JOURNAL

OF THE

ELECTRICITY DEPARTMENT

GOVERNMENT OF MADRAS

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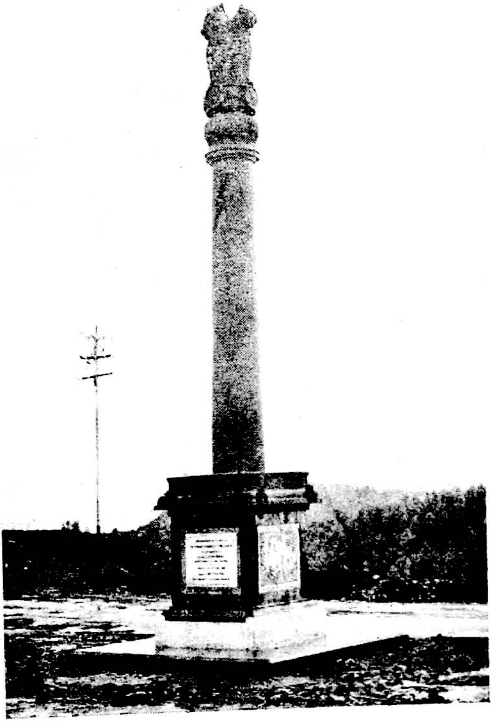
. XI JULY—SEPTEMBER 1956 No. 2



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OF THE ELECTRICITY DEPARTMENT GOVERNMENT OF MADRAS

VOL. XI JULY—SEPTEMBER 1956 No. 2

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Inauguration of Jog Supply to South Kanara

By the **EDITOR.**

POWER SUPPLY from Jog Power House was switched on to the South Kanara district by Sri K. Hanumanthayya, Chief Minister of Mysore State, in July, 1956.

The function inaugurating Jog supply to the southern portion of the district was held near Maroli Sub-station on 7th evening and that to the Northern portion at Hiriadka on 8th evening. The function at Maroli Sub-station was presided over by Sri A. B. Shetty, Minister for Health and the one at Hiriadka by Sri T. A. Pai, M.L.A., Madras.

Sri M. B. Kandaswamy, Chief Operation Engineer (South) gave a brief report of the Jog Power Supply Scheme for South Kanara, welcoming the Minister and other honourable guests on behalf of the Chief Electrical Engineer, Madras, who was unavoidably absent. He stated that they were just seeing the fruition of a Scheme, that was under contemplation for the past 15 years, and described briefly the details of the Scheme for the benefit of the guests assembled. He said,

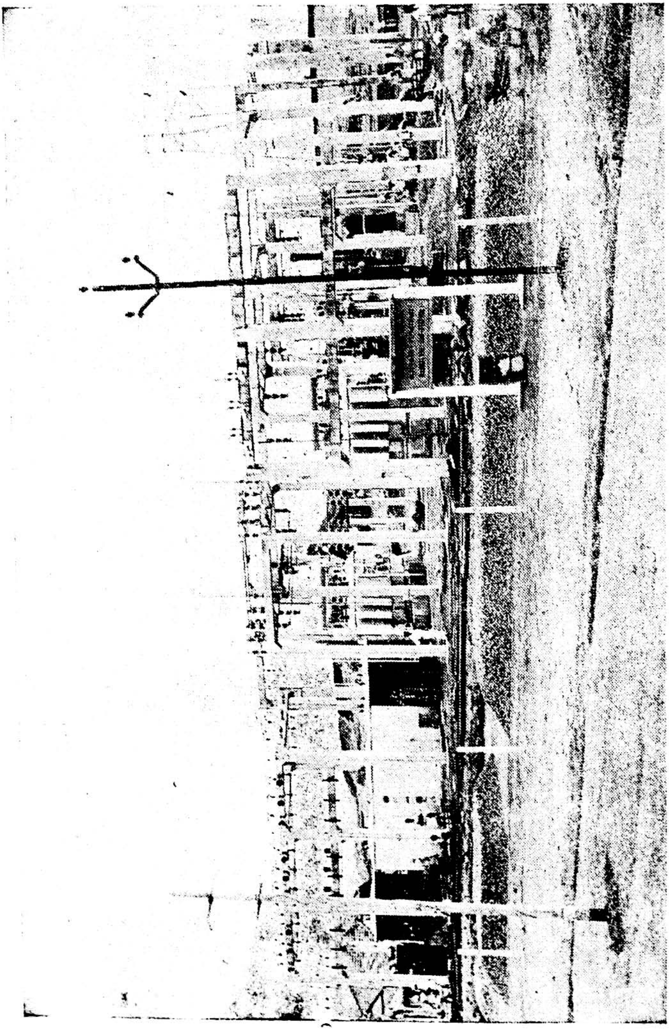
"Extension of power supply to the South Kanara district from Cannanore was studied in 1944, vis-a-vis purchase of Jog power in bulk from Mysore State. The latter was found to be more economical and a proposal for such purchase and extension was got ready, but its consideration in war time had to be put off. After the war, the scheme was considered afresh. Proposals for taking supply at 66 K.V. to the extent of 6,000 K.W. were first formulated; but later modified for 110 K.V. at the suggestion of the Mysore Government. The revised scheme, costing Rs. 7 lakhs initially and, rising to 88 lakhs in ten years, was sanctioned in 1952. The Scheme was taken up for execution in 1953 after conclusion of power agreement with the Mysore State.

"The works include,

(1) erection of 75 miles of 110 K.V. single circuit line from Hulikal on the border of Mysore State to Hiriadka and Mangalore with sub-stations at Hiriadka and Mangalore;

(2) erecting 50 miles of 33 K.V. lines from Hiriadka to Coondapur, Udipi and Karkala with 33 K.V./11 K.V. sub-stations at these places.

As a preamble to the above scheme, the Udipi and Karkala Electric Supply Undertakings had been acquired in 1951 and improvements to Udipi Power House, advance construction of lines to Coondapur and Karkala, etc., carried out at a cost of 9·5 lakhs."



Mangalore 110 KV. Substation Yard.

"Expenditure incurred on Jog Power Scheme," he said, "worked out to Rs. 52·7 lakhs till May, 1956 with power supply extended to 32 villages in the district. Schemes under execution at the time cost 20 lakhs and would, on completion, extend supply to 36 more villages. Besides, eight major schemes costing 11·2 lakhs were to be taken up shortly. These, with the five schemes costing 23·6 lakhs under consideration, would enable extension of supply to 24 more villages."

The Chief Operation Engineer said that a provision of Rs. 85 lakhs had been made for power distribution in the district to about 150 villages and 1,600 pumpsets, in the Second Five-Year Plan. He concluded his speech, with expression of gratefulness to the Mysore Government for execution of their works much earlier than scheduled, and calling on the people in the district to co-operate and make the scheme a great success.

Sri A. B. Shetty, Minister, speaking on the occasion pointed out that the economic development of a country and the standard of living attained by its people, were principally estimated by the extent of power development in the country. The per capita consumption of economically advanced countries of Europe ranged from 2,000 to 4,000 units, as against the 25 units in India at present. The First Five-Year Plan helped to increase the installed capacity of power plants from 2·3 million K.W. to 3·5 million K.W. The capacity is expected to rise to 6·8 million and the per capita consumption to 50 units at the end of the Second Plan. Speaking about Madras State, the Minister stated that the installed capacity of power plants increased from 156 M.W. to 256 M.W. in the First Plan and supply now was being given to 3,500 villages and 33,000 agricultural pumpsets. Another 2,500 villages and 30,000 pumpsets are expected to be connected up during the Second Plan period.

Inaugurating the Jog Scheme to South Kanara, Sri K. Hanumanthayya, Chief Minister, Mysore State, stated that this was an achievement of a long cherished demand of the area. Electricity was one of the most essential factors for the economical development of a country, he said. If a country should make fast progress, the people should use more and more electricity, which was the foundation for the development of a country.

The Chief Minister next dealt with the power aspects of the Five-Year Plan and said that in the Second Plan it was proposed to increase power production by 70 lakhs K.W. in the country and thus help to improve the economic standard of the common man. With particular reference to Mysore State, the Chief Minister observed that Mysore was the first State in the country to start electricity production by the installation of the first hydro-electric station at Shimsha with a maximum production of 20 M.W. The total installed capacity had now increased to 120 M.W. in the State. The Mysore Government had a very ambitious programme, he said, to increase power production, from the different hydro-electric systems, from

120 M.W. to 700 M.W., under the Second Five-Year Plan, for which they had to spend nearly Rs. 20 crores.

Concluding his speech, the Chief Minister reminded the people that, our country was predominently an agricultural country, for the economical development of which, more and more electricity should be made available to the rural areas and modern methods in agriculture should be adopted. The Mysore Government, he said, appreciated the importance of rural electrification and had an ambitious programme of extention of electric supply to rural areas in the State with this increased production of power in the Plan period. The new Kannada State was being formed of people from five different States, and it was their duty he said, to work together, unitedly as one family for the advancement of the State.

Inauguration of the Kundah Hydro-Electric Scheme

By the EDITOR.

THE KUNDAH HYDRO-ELECTRIC SCHEME, the largest of the schemes so far undertaken by the Department was inaugurated by the Union Minister for Finance, Sri C. D. Deshmukh, on 29th June 1956, at Kundapalam, Nilgiris. This date will ever remain memorable for all the staff of the Electricity Department as the date of inauguration of the largest scheme so far undertaken by the Electricity Department.

The day started with prayer, and puja in the morning. After puja, the Chief Engineer for Electricity, Sri V. P. Appadurai, hoisted the national flag and in a brief speech explained the achievements under the First Plan and the ambitious targets proposed for the Second Plan. He exhorted the staff of the Department to continue the enthusiasm with which they organized the inauguration function and strive hard with unabated zeal, with the one objective in view, viz., the quick and satisfactory completion of the Project, as per scheduled programme, and, what is more, within the sanctioned estimates.

Sri M. B. Kandaswamy, Chief Operation Engineer (South) speaking on the occasion explained the activities of the Department and gave a few words of advice to the staff to work hard for the satisfactory completion of the schc

From 8-30 a.m. the guests and invitees began to arrive and they were all accommodated in the spacious and gaily decorated pandal.

The chief guest, Sri C. D. Deshmukh, Mrs. Deshmukh, Shri Sri Prakasa, Governor of Madras and party, the State Finance Minister, Sri C. Subramaniam and the State Public Works Department Minister, Sri Shanmugha Rajeswara Sethupathi arrived in time and were received by the Chief Engineer for Electricity. The inaugural function was presided by Shri Sri Prakasa, Governor of Madras.

The proceedings commenced with prayer. Sri R. M. Thirumalaikolundu, Executive Engineer, read the messages received from high personages, who could not attend the function. The Chief Engineer welcomed the Governor of Madras and the Union Finance Minister and expressed his gratitude to them—to the Governor, for agreeing to preside over the function, leaving aside his other multifarious duties, and to the Union Finance Minister for agreeing to inaugurate the Project, in spite of other pressing engagements. In a brief speech, the Chief Engineer gave a fairly detailed account of the Kundah Hydro-Electric Scheme and the substantial aid, the Department was able to obtain, from the Canadian Government under the Colombo Plan.*

The Chief Engineer referred to the lively interest, shown by the Union Finance Minister, and said he was grateful to the Ministry of Finance, Governments of India and Canada for placing the Kundah Hydro-Electric Project among the list of schemes to receive aid under the Colombo Plan.

Thereafter Sri C. D. Deshmukh declared the scheme as having been inaugurated, by pressing electric buttons, which unfurled the screens covering the commemoration tablets fixed to the Asoka Pillar specially erected for the purpose and which is reproduced on the cover page. The Union Finance Minister in his inaugural address paid a tribute to the skill and ability of the South Indian engineers in the investigation and construction of large schemes and wished all success to the Government in the early completion of the Kundah Project. He also desired that the scheme should be completed within the sanctioned estimate.

The Governor of Madras, Shri Sri Prakasa also spoke in appreciation of the work done by the Madras engineers.

The Chief Engineer for Electricity then announced the removal of the entire power cut then prevalent in the State "in honour of the visit of Noble Sons of India" which was greeted with loud cheers and applause.

The function concluded with the vote of thanks proposed by Sri G. Venkatraman, Superintending Engineer, Kundah Hydro-Electric Scheme and with the singing of the National Anthem.

After the function, the guests were taken round the models of the scheme. The details of the scheme

* Extracts from the speech of Chief Engineer are separately published for the benefit of the readers of this Journal.

were explained by the Chief Engineer for Electricity. The guests and invitees were entertained with light refreshments and tea at a specially erected pandal. During the time there was light music, and entertainment.

In spite of inclement weather, a large number of guests from Ootacamund, Coonoor, Mettupalayam and Coimbatore attended the function, and the local public from neighbouring villages took lively interest in the function. The function was indeed a grand success.

The Kundah Hydro-Electric Scheme

By Sri V. P. APPADURAI, B.A., M.I.E. (Ind.),
Chief Engineer for Electricity.

THE KUNDAH HYDRO-ELECTRIC SCHEME is the biggest of the new power schemes of the Second Five-Year Plan of the Madras State. This is also the biggest of the schemes so far undertaken by the Madras State, and when completed will add 180 M.W. to the State Grid.

The Kundah Hydro-Electric Project in the Nilgiris is one of the projects mentioned by Mr. J. W. Meares (Chief Engineer for Hydro-Electric Survey of India) in his "Preliminary Report on the Water Power Resources of India" published in 1919. In that report the power envisaged was only about 15 M.W. utilising a head of 3,000 feet. The above estimate for power is a very low figure and the scope of the scheme, as now enlarged by the additional flow from neighbouring basins, is intended to generate a firm power of 129 M.W., with an installed capacity of 180 M.W. in the initial phase.

History of the Scheme.

The history of the Scheme may be traced from about 1931, when a concession for developing power from the Kundah falls was given to Messrs. Tatas. No attempts were however made by them to develop power and the concession appears to have lapsed or been subsequently withdrawn.

In 1927, the Government of Madras initiated the policy of active development of the power resources of the State and the Pykara, Mettur and Papanasam Hydro-Electric Schemes were the first three Hydro-Electric Schemes to be developed by the Madras State and these came into commission in 1932, 1936 and 1944, respectively.

During the war years, no progress could be made, as new schemes or extensions were barred, and after the end of World War II, a number of new schemes were sanctioned. Due to the post-war developments, and consequent increase in power demand and the acute shortage of power experienced in the Madras Grid, the necessity for going in for new power resources was keenly felt even after the commissioning of the extensive schemes covered by the post-war plan. The Madras Electricity Department therefore undertook in 1947 a State-wide study of hydro-electric resources of the Madras State, under which the investigation of Periyar and Kundah were given top priority. Moyar Hydro-Electric Scheme, Pykara III Stage, Madurai Thermal Scheme, Madras Plant Extensions—Stage I and Stage II, etc., were the important schemes commissioned in the First Five-Year Plan, with a total installed capacity of 110 M.W., but even so the demand for power has been outstripping the generating

capacity. The Periyar Hydro-Electric Scheme was taken up for construction in February 1955 and will add 105 M.W. in the first stage and 140 M.W. in the second stage, when completed in 1958–59.

Topography of Kundah Basin.

The Kundah Basin is situated to the south-east of the Pykara Basin in the Nilgiris. Two streams, the Avalanche and the Emerald rising amidst the group of high peaks, Devabetta, Karaikadu, Koulinbetta and Porthimund, all over 8,000 feet in altitude, combine to form the Kundah river. After the confluence, the river takes a south-easterly course and is joined by the Sillahalla stream near Mandanai at an altitude of 6,000 feet. The Kundah has then a fall of about 200 feet and after running in cascades for about 2,000 feet, is joined by the Kanarhalla stream on its right at an altitude of about 5,280 feet. The Pegumbahalla stream joins the Kundah further down at a level of 2,100 feet, and beyond that confluence, the Kundah river runs in rapids, for about a mile and a half, and later, in an easy gradient, down to its junction with the Bhavani at an altitude of 1,340 feet.

Power Development.

The general plan and profile of the Scheme are attached. It is proposed to develop the catchment of the Kundah Basin in three power stations and only the initial phase of the scheme involving the construction of two power houses has been investigated in detail and will be taken up during the plan period. During this phase, it is proposed to build four dams (including the forebay dam), two power tunnels, an interconnecting unlined tunnel, two sets of penstocks and two power stations. Each of the two dams across the Avalanche and the Emerald rivers will be nearly 200 feet in height and will be of stone masonry in cement mortar. Their lengths at top, will be 1,200 feet and 1,060 feet respectively. The upper Bhavani dam will be 1,090 feet long, 216 feet in height, and will be of straight gravity non-over-flow type built in masonry.

The forebay dam near Kundapalam will be about 100 feet in height, and 400 feet in length, at the top. The power tunnels (Nos. 1 and 2) will be about 14,000 feet and 12,000 feet respectively, with net diameter of 10 feet and 10 feet 9 inches respectively. They will be lined with cement concrete throughout. To connect the Upper Bhavani reservoir with the Emerald Avalanche reservoir, an unlined tunnel; 8,450 feet, long will be bored through the intervening ridge.

During the initial stage, only two penstocks will be laid for Power house No. 1 with space provision for the 3rd to be erected at a later date. The penstocks will be of 5 feet 3 inches internal diameter at the top, tapering to 4 feet 6 inches diameter at the power house end, and is designed for a peak discharge of 240 cusecs. Each penstock will feed its own machine on the unit system.

The Power House No. 1 will be located on the right bank of Kundah and the second power station on the left bank of Pegumbuhalla about a mile and a half, above its

confluence with the Kundah. Initially, there will be two generating sets of 20 M.W. coupled to 2 units of 28,750 H.P. turbines with a net head of 1,193 feet at Power House No. 1.

The Power House No. 2 will have four penstocks each 5,500 feet long designed for a peak discharge of 200 cusecs each. The individual penstocks proposed will be of 4 feet 9 inches internal diameter, tapering to 3 feet 9 inches at the power house end. The power house will have four 50,000 H.P. turbine units each directly coupled to 35,000 K.W. 11 K.V. Generators with a net head of 2,340 feet.

Thus the total installed capacity in the two power houses will be 180 M.W. Provision will be made for adding one more unit in Power House No. 2 in the next stage.

In the next stage, the flows from the East and West Varahapallam streams will also be utilised by the construction of necessary dams and tunnels. The flows from the western catchments will also be diverted into the Porthimund reservoir and thence into the Emerald Valley by a tunnel. The penstock and generating capacities in the two power stations will also be increased suitably.

In the ultimate stage the tail race waters of Power House No. 2 in combination with the free flow of Pegumbuhalla will be utilised in a third power house which is proposed to be located underground at a level of about 1,300 feet. The gross head at this power station will be about 1,555 feet. The last two stages require further detailed investigations which will be taken up in due course.

On the whole, it is proposed to utilise a gross head of nearly 5,200 feet in the three power stations in the ultimate stage of development.

The power generated at Kundah will be fed into the Madras Grid through a system of 110 K.V., 66 K.V. and 33 K. V. lines. The following 110 K.V. lines will be erected initially :—

	MILES.
1 Singarappet-Villivakkam D.C. line.	124
2 Kundah Power House No. 2 to Salem D.C. line.	110
3 Kundah Power House No. 2 to Coimbatore D.C. line.	25
4 Salem-Singarappet D.C. line.	56
5 Kundah Power House No. 2 to Kundah Power House No. 1 D.C. line.	5

In addition to the above, provision has been made for 85 miles of 110 K.V. lines, 158 miles of 66 K.V. lines and 200 miles of 33 K.V. lines to be erected in future, as and when necessary.

The salient features of the Scheme are given in the Appendix. The whole scheme is expected to cost about Rs. 3,544 lakhs including transmission lines and is expected to yield a net return of 4 per cent from the tenth year of operation.

Canadian Aid for the Scheme.

During the visit of the Canadian Administrator of the Colombo Plan, Mr. H. G. Nic Cavell, to India in February 1955, the Government of India among other schemes suggested the possibility of providing the power house requirements of the Kundah Scheme under the Canadian Aid. In a conference held with the Madras Government representatives, the technical aspects of the scheme were explained by the Consulting Engineer to Government and the Chief Engineer for Electricity. As a result of the Canadian Administrator's keen interest, the Canadian Government deputed during November 1955, Mr. D. Stairs and Mr. J. K. Sexton of Messrs. Montreal Engineering Company, consultants to the Canadian Government. The consultants visited the project site, and had discussions with the engineers of the Department. As a result of their favourable recommendation, that the Scheme is technically sound, a deputation consisting of Sri C. V. Narasimhan, Joint Secretary, Ministry of Finance, Department of Economic Affairs and the Author went to Canada in May 1956 for further discussions and finalising the agreements. The discussions were successfully concluded and the Canadian Government have since agreed to give aid to the tune of 20 million dollars (about Rs. 10 crores) by way of materials.

The Canadian Government will supply the following for civil works :—

(i) Gates, screens, valves, etc., for the dams.

(ii) Low pressure pipe line, penstock, meters and valves.

(iii) Steel structurals and accessories for buildings for power houses I and II.

(iv) Construction equipment for the civil works.

The power house equipments to be supplied by the Canadian Government will be as follows :—

(i) Turbines, inlet valves and accessories.

(ii) Generators, exciters, voltage regulators and accessories.

(iii) Switchgear.

(iv) Power house auxiliaries including fire protection equipments.

(v) Step up transformers and accessories.

(vi) Power and control cables.

(vii) Handling equipments, crane and accessories.

The Canadian Government will also supply the sub-station equipments and transmission line equipments, subject to the total aid being limited to 20 million dollars.

Now that the Scheme receives assistance from the Canadian Government by way of materials and equipments, it is expected, that the scheme could be pushed through and completed earlier, than originally envisaged. The first unit is expected to be commissioned by the end of 1959, and all the plants in both the power houses by the end of 1960. The construction works of the main storage dams are expected to be completed by 1961.

APPENDIX.

Salient Features of the Kundah H.E. Scheme.

Serial number and description.	Stage 1. Power House No. 1.	Stage 1. Power House No. 2.	Stage 2. Power House No. 1.	Stage 2. Power House No. 2.
1. Catchment area in square miles ..	22·6	66·6	35·4	79·4
2. Storages proposed in M.cft. (net capacity).	5400	5400	8447	8447
3. Head available in feet. Maximum (gross).	1180	2470	1180	2470
4. Power draught available in cusecs :				
a. Minimum power draught available for 100 per cent of the time, in cusecs.	130	211	253	350
b. Peak demand at 60 per cent load factor over minimum power draught.	217	352	422	583
5. Energy available :				
a. Average continuous firm power available for 100 per cent of time in M.W.	9·70	35·27	18·88	58·51
b. Peak demand at 60 per cent load factor (firm power) in M.W.	16·17	58·83	31·47	97·45
c. Energy available in a year for 100 per cent time expressed in Mil. K.W.H.	85·00	308·9	165·4	512·5
d. Energy available in an average year expressed in Mil. K.W.H.	94·82	370·5	179·8	568·0
6. Proposals :				
a. Penstocks (capacity in cusecs) ..	*2—250 =500	†3—200 =600	2—250 =500	4+200 =800
b. Generating sets (capacity in M.W.).	*2—20 =40	†3—35 =105	2—20 =40	4—35 =140

7. *General features* :

F.R.L. of Avalanche-Emerald Reservoir	+6515 ft.
Height of the two dams, about	200 ft.
Level of *Power House* number 1	+5335 ft.
F.R.L. of Kundapalam forebay dam	+5330 ft.
Height of Kundapalam forebay dam	94 ft.
Level of *Power House* number 2	+2860 ft.
Height of Upper Bhavani dam about	220 ft.
Height of earth bund on saddle in Upper Bhavani	65 ft.

8. Transmission Lines :
Initial phase—
320 miles of 110 K. V. Double Circuit Line.

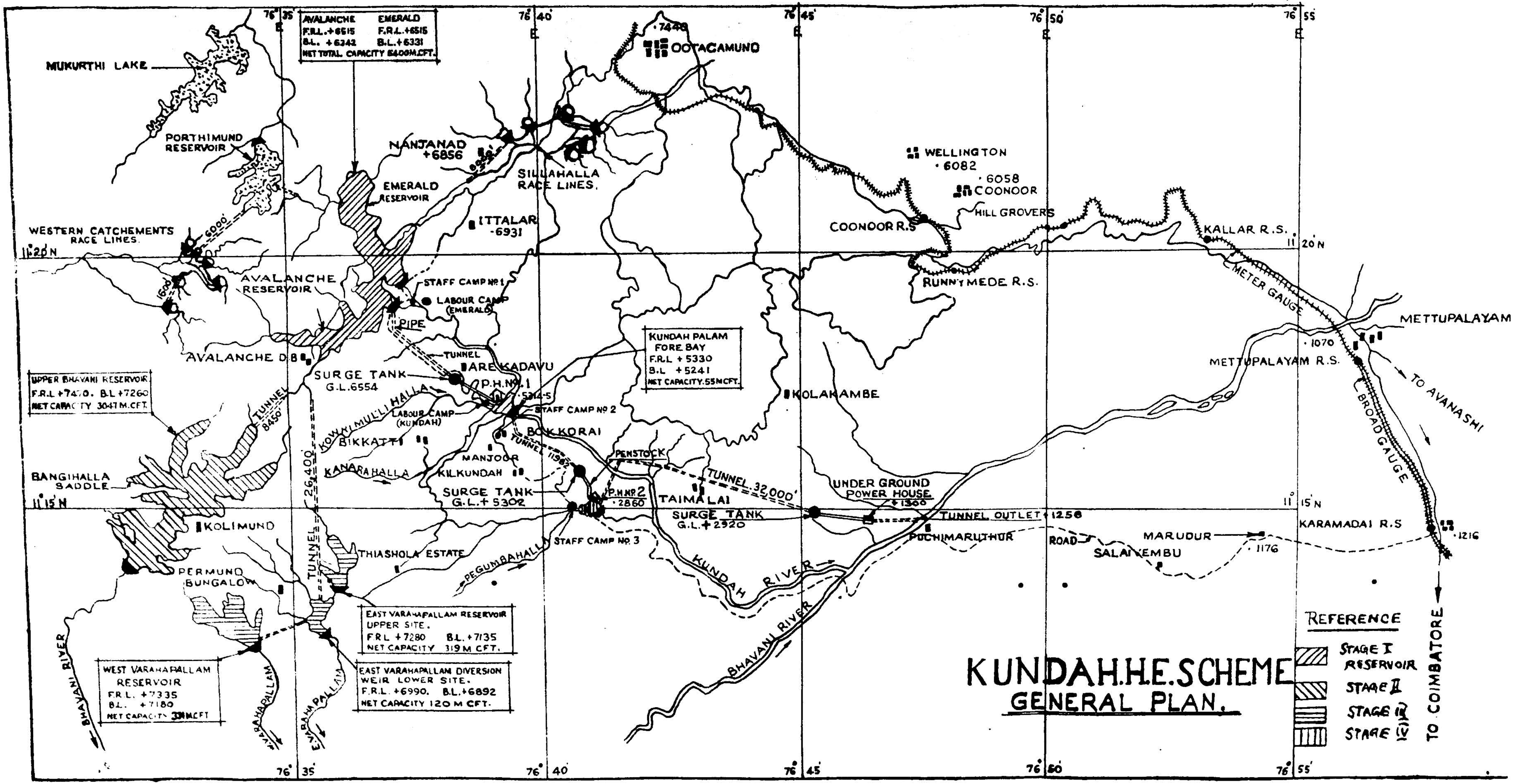
9. Estimated cost and return:

	RUPEES IN LAKHS.
Capital expenditure for Stages 1 and 2	3544·01
Arrears of interest	434·12
Sum at charge	3978·13
Net revenue in 10th year	158·80
Percentage return	4 per cent

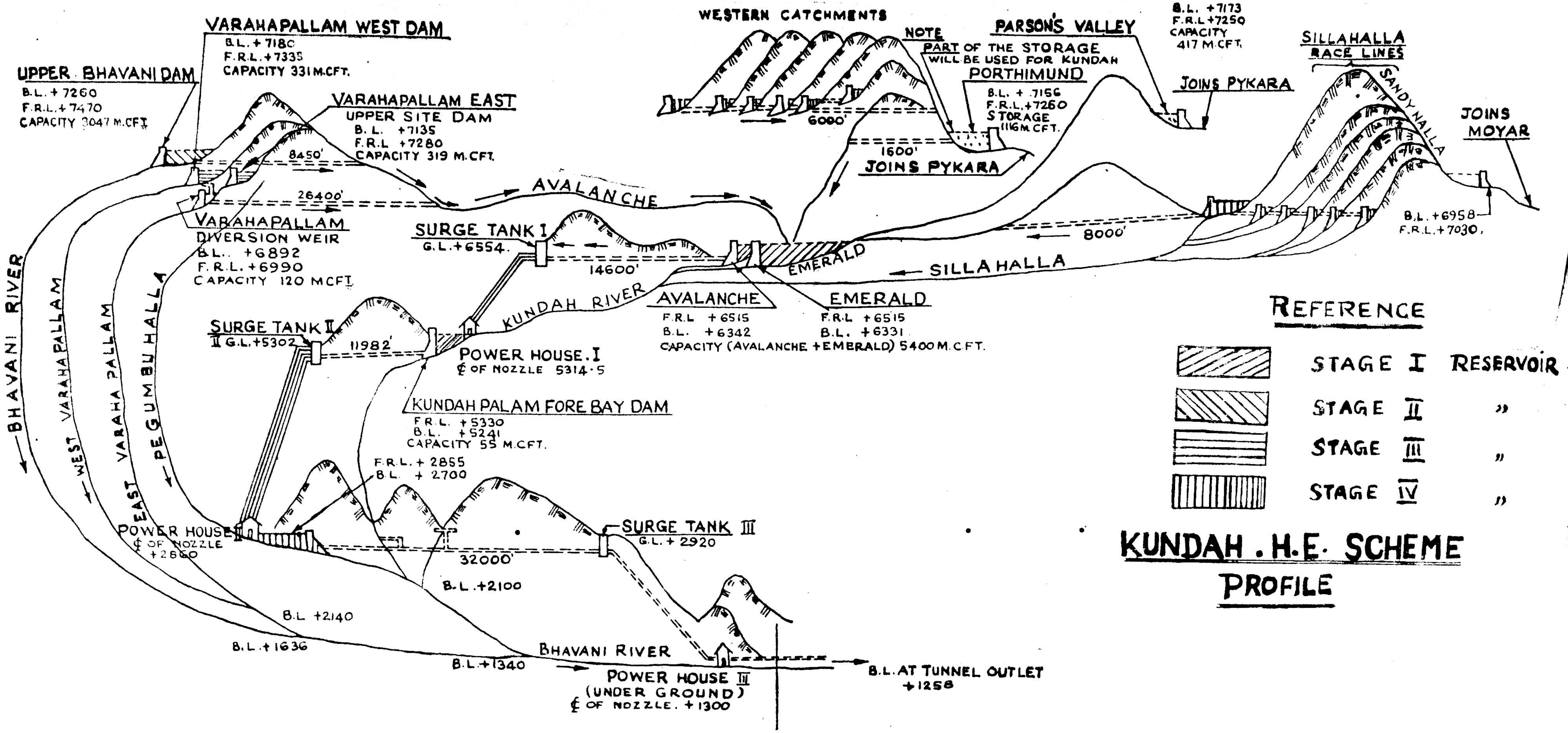
* Space provision for the addition of a third penstock, generating set will be made at P.H. 1 in stage 1 itself for future stages of development.

† Space provision for the addition of a fifth penstock, generating set will be made in the first stage itself at P.H. 2.

The Kundah river to be harnessed under the Kundah H.E. Scheme.



KUNDAH.H.E.SCHEME
GENERAL PLAN.
REFERENCE
STAGE I RESERVOIR
STAGE II
STAGE III
STAGE IV
AVALANCHE EMERALD
F.R.L. +6515 F.R.L. +6515
B.L. +6242 B.L. +6331
NET TOTAL CAPACITY 5400M.CFT.
MUKURTHI LAKE
PORTHIMUND RESERVOIR
WESTERN CATCHEMENTS RACE LINES.
AVALANCHE RESERVOIR
AVALANCHE D.B.
EMERALD RESERVOIR
NANJANAD +6856
SILLAHALLA RACE LINES.
ITTALAR ·6931
OOTACAMUND
·7440
WELLINGTON ·6082
·6058 COONOOR
HILL GROVERS
COONOOR R.S.
RUNNYMEDE R.S.
KALLAR R.S.
METER GAUGE
METTUPALAYAM
·1070
METTUPALAYAM R.S.
TO AVANASHI
BROAD GAUGE
KARAMADAI R.S.
·1216
TO COIMBATORE
STAFF CAMP No.1
LABOUR CAMP (EMERALD)
PIPE
TUNNEL
ARE KADAVU
SURGE TANK G.L.6554
P.H.No.1
STAFF CAMP No 2
KUNDAH PALAM FORE BAY
F.R.L +5330
B.L +5241
NET CAPACITY.55M.CFT.
KOLAKAMBE
UPPER BHAVANI RESERVOIR
F.R.L +7470. B.L +7260
NET CAPACITY 3047M.CFT.
TUNNEL 8450'
KOWNMULLI HALLA
LABOUR CAMP (KUNDAH)
BIKKATTI
BOKKORAI
MANJOOR
TUNNEL 11982'
KANARAHALLA
KILKUNDAH
PENSTOCK
TUNNEL 32,000'
BANGIHALLA SADDLE
SURGE TANK G.L.+5302
P.H.No 2 ·2860
TAIMALAI
UNDER GROUND POWER HOUSE +1360
SURGE TANK G.L.+2920
TUNNEL OUTLET +1258
PUCHIMARUTHUR
ROAD
MARUDUR
·1176
SALAIYEMBU
KOLIMUND
TUNNEL 26,400'
THIASHOLA ESTATE
STAFF CAMP No. 3
PEGUMBAHALLA
KUNDAH RIVER
BHAVANI RIVER
PERMUND BUNGALOW
EAST VARAHAPALLAM RESERVOIR UPPER SITE.
F.R.L. +7280 B.L. +7135
NET CAPACITY 319 M CFT.
EAST VARAHAPALLAM DIVERSION WEIR LOWER SITE.
F.R.L. +6990. B.L. +6892
NET CAPACITY 120 M CFT.
WEST VARAHAPALLAM RESERVOIR
F.R.L. +7335
B.L. +7180
VARAHAPALLAM
EVARAHAPALLAM
76° 35' E
76° 40' E
76° 45' E
76° 50' E
76° 55' E
11° 20' N
11° 15' N


VARAHAPALLAM WEST DAM
B.L. + 7180
F.R.L. + 7335
CAPACITY 331 M.CFT.
UPPER BHAVANI DAM
B.L. + 7260
F.R.L. + 7470
CAPACITY 3047 M.CFT.
VARAHAPALLAM EAST
UPPER SITE DAM
B.L. +7135
F.R.L +7280
CAPACITY 319 M.CFT.
8450'
26400'
AVALANCHE
VARAHAPALLAM
DIVERSION WEIR
B.L. +6892
F.R.L. +6990
CAPACITY 120 MCFT.
SURGE TANK I
G.L.+6554.
14600'
KUNDAH RIVER
SURGE TANK II
II G.L.+5302
11982'
POWER HOUSE. I
₵ OF NOZZLE 5314·5
KUNDAH PALAM FORE BAY DAM
F.R.L. +5330
B.L. +5241
CAPACITY 55 M.CFT.
F.R.L. + 2855
B.L. + 2700
POWER HOUSE
₵ OF NOZZLE
+2860
SURGE TANK III
G.L. + 2920
32000'
B.L. +2100
B.L. +2140
B.L. +1636
B.L. +1340
BHAVANI RIVER
POWER HOUSE III
(UNDER GROUND)
₵ OF NOZZLE. +1300
B.L. AT TUNNEL OUTLET
+1258
BHAVANI RIVER
WEST VARAHAPALLAM
EAST VARAHA PALLAM
PEGUMBU HALLA
WESTERN CATCHMENTS
6000'
NOTE
PART OF THE STORAGE
WILL BE USED FOR KUNDAH
PARSON'S VALLEY
B.L. +7173
F.R.L.+7250
CAPACITY
417 M.CFT.
PORTHIMUND
B.L. + 7156
F.R.L.+7260
STORAGE
1116 M.CFT.
1600'
JOINS PYKARA
JOINS PYKARA
SILLAHALLA
RACE LINES
SANDYNALLA
JOINS
MOYAR
B.L. +6958
F.R.L. +7030.
8000'
EMERALD
SILLAHALLA
AVALANCHE
F.R.L +6515
B.L. +6342
EMERALD
F.R.L +6515
B.L. +6331
CAPACITY (AVALANCHE +EMERALD) 5400 M.C.FT.
REFERENCE
STAGE I RESERVOIR
STAGE II ,,
STAGE III ,,
STAGE IV ,,
KUNDAH . H.E. SCHEME
PROFILE

H.T. Transmission Lines across Wide River Beds

By Sri U. P. NAYAK, B.E.,
Divisional Engineer (Electrical)

I. Introduction.

THE HIGH TENSION TRANSMISSION lines from generating stations to load centres sometimes have to be routed across wide sandy river beds. These rivers carry a large volume of water during floods at great velocity, spread over a width of about 2 to 4 miles. They also carry a large quantity of floating matter like huge trees uprooted, dead bodies of animals, etc., and any structure placed in the centre of river beds is likely to be hit and damaged.

When it is not possible to cross such rivers in one single economical span, it becomes of course necessary to introduce intermediate supports in the river beds. Such intermediate supports have to be designed suitably,

(1) to keep the steel frame-work above maximum flood level,

(2) to give sufficient free board below the conductors to avoid accidental contact with floating matter during maximum floods, and also

(3) with the foundation, sufficiently deep and strong, to take care of scour action at the point of support.

For transmission lines up to 33 K.V., taken across rivers, where flood is controlled by dams, barrages, etc., it is usual to adopt steel tubular poles or rolled steel joists for carrying the power conductors. For lines of voltages, 66 K.V. and above, special steel latticed towers or pylons are designed for the river crossings in order to reduce the number of towers to be erected inside the river bed to the minimum, consistent with the overall cost of the entire crossing.

2. Pole foundations.

In the case of tubular poles or R.S. joists, hume-pipe foundations have been generally found to be satisfactory and adequate. The work of sinking the hume pipes is usually done, when the river is dry, and the

method of construction adopted is as follows :—

First the exact location and alignment of the support is fixed by means of theodolite. Then the R.C.C. hume-pipe generally of 8 feet length and suitable diameter varying from 33 inches to 48 inches, according to the design, is placed vertically at the correct site, and sunk by scooping out sand from inside the hume-pipe. The pipe sinks by its own weight for the first three or four feet and after that the pipe is weighted by loading it with sand bags to facilitate sinking. Where water is met with, natural diving is adopted to remove sand from inside the hume pipe. Generally clay or hard ground is not met with, in the rivers within 8 feet, and so the sinking process is not difficult.

After the hume pipe has been sunk to the full depth, that is, till the top of the hume pipe reaches the bed level of the river, four rails are driven into the pipe in a diamond formation, close to the inner wall of the pipe, till they reach the hard soil or stiff clay in the river bed. Then the lengths protruding above the hume pipes are cut off. A rich mix of concrete with 1 : 1½ : 3 proportion is then laid inside the hume pipe for a depth of about 6 inches. As water cannot be baled out from the hume pipe dry mix concrete is put in by lowering it in a gunny bag and carefully depositing it by opening the bag when it is at the bottom of the pipe. This sealing layer of concrete is allowed to set for about forty-eight hours and then the water inside the hume pipe is baled out. The transmission pole is next lowered into the hume pipe and correctly aligned. Cement concrete with 1 : 2 : 4 proportion is then poured into the humepipe for the full depth. A concrete sleeve with cut-water section is provided around the pipe, up to one foot above the maximum flood level of the river.

3. Tower foundations.

For transmission lines of 66 K.V. and above, steel towers are usually erected on piers built over well foundations, the bottom of which is taken sufficiently below the anticipated deep scour in the river bed at the location of the piers.

The type of wells and the depth to which they have to be sunk are dependent on the nature of the soil met with below the river bed. To determine this, borings are taken at sites of piers proposed. It sometimes happens that stiff clay or hard rock is not met with for considerable depths, in which case, the foundations are designed to suit sandy beds and taken very deep, as in the case of the Krishna river crossing on the Vijayavada-Ongole 132 K.V. line, where the foundation of the tower in the deepest bed has been taken down to 76 feet below the bed, the pier over the river bed itself being 35 feet.

4. Well sinking.

The work of well sinking for the tower foundations is essentially a seasonal work, as during floods and when river is flowing, no work can be done. The method that is adopted for the sinking of the wells is the method that is generally adopted in the construction of bridges. The

two methods commonly known for sinking wells are—

(1) Natural diving without any equipment.

(2) Pneumatic diving.

Natural diving depends mostly on the skill and capacity of the diver, and being extremely slow, is neither suitable nor economical for tower foundations.

Pneumatic diving is generally done with the aid of air-fed helmets with a diving dress or with air-locked pneumatic caissons. The photograph overleaf illustrates the method of pneumatic diving with air-fed helmet, and shows a diver with his head completely covered by the helmet : the feeding-in hose pipe, etc.

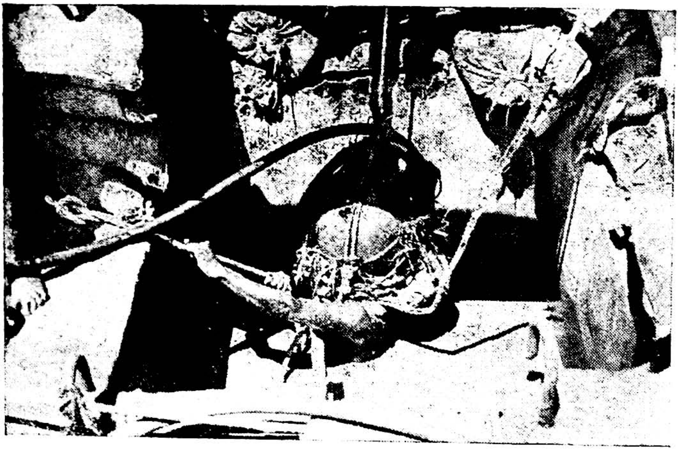
The well sinking process is briefly described below :—

First, an R.C.C. curb is cast at the exact site of the tower, as fixed with a theodolite instrument, and after it has set, it is sunk by scooping out sand from inside the curb. Then six feet height of the steining is built over the curb using steel formers and this is sunk up to the ground level by removing sand from the well. The steining sinks by its own weight, but in order to quicken the sinking process sand bags are placed on the top of the well. After the first height of steining is sunk, the second height is cast and the same process of sinking and building the steining is continued until the wells are sunk to the required depth.

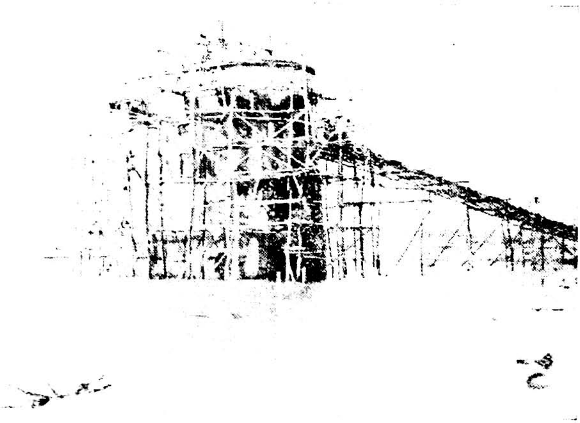
For sinking of wells the natural diving method is not much useful beyond a depth of three feet, and pnuematic diving with air-fed helmets is mostly adopted. The helmets are made out of copper plate, adequate to cover the head and shoulders only. They are provided with an air inlet at the top and are fed with compressed air through a flexible hose from an air receiver. When the helmet is fed with compressed air and the diver sinks into the water, the air escapes through the bottom of the helmet freely and prevents the water from rising into the helmet due to the air pressure. The body of the diver above the shoulder is not subjected to any air pressure from outside, except the pressure of the air taken in due to breathing in the compressor air, in the helmet.

For every 33 feet below water, the pressure increases by one atmosphere (14·7 lbs. per square inch) in excess of the atmospheric pressure. Thus at 75 feet depth the pressure will be of the order of about 47 lbs. per square inch, and therefore for sinking wells up to 70 to 80 feet, compressed air fed into the helmet should have a pressure of not less than 60 to 70 lbs. per square inch to prevent the water from rising into the helmet. Hence compressors which can give compressed air at 90 to 100 lbs. per square inch are usually used for this work. The compressors are either petrol driven or electrically driven and are always provided with air receivers of about 100 c.ft. capacity sufficient to supply air at the pressure for at least five minutes in the event of failure of the compressor, as the risk of failure of supply of compressed air may sometimes prove fatal to the diver. Each helmet requires 12 to 15 c.ft. of compressed air per minute and each pneumatic clay digger about 10 c.ft. per minute.

The diving operation is normally conducted as follows :—



The diver with helmet on.



The completed pier.

The diver puts on the helmet over his head resting it on his shoulders vide photo on page 64. In order to overcome the buoyancy effect under water, the helmet is weighted with iron chains, wound round it. A thin rope, usually called the 'Life Line' is passed round the diver's left arm near the shoulder, and this is used for signalling from the top of the well, in raising and lowering the diver. The diver sinks to the bottom and removes the sand by means of a spade and fills it into the buckets. These buckets are lifted by manual labour or power-operated hoists and emptied outside the well.

The sinking of wells by compressed air involves great risk below 30 to 40 feet depth and requires extreme care on the part of both the diver and the control operators from the top. After continuous work for some hours under water, the ascent to the surface should be made by the diver slowly, with stoppages at intervals. Otherwise the sudden change of pressure on the body tends to cause paralysis or even death, according to the physical capacity of the diver, to stand the change. Normally the divers can work up to about three hours at a stretch in the earlier stages and one and half to two hours only when the depth is more than 40 feet below the surface.

When layers of clay are met with, as is usually the case, in all river-beds, ordinary crowbars and shovels will not be useful to remove the clay and pneumatic clay diggers operated by compressed air will be necessary. The higher skin friction of the clayey strata retards the progress of sinking and the sinking will not be uniform, as in sandy strata.

As the wells go deeper and deeper, tilting of the wells is quite usual. This tilting of wells is reduced by placing sand bags and weighty materials on the top of the wells to suit the tilts and scooping the sand from inside the wells as required. Another method that is adopted for removing tilts is to provide wooden rollers and wedge pieces between the wells. It has been observed that beyond 60 feet depth, removal of tilt is extremely difficult. The photograph on page 64 shows a completed pier at deep bed location with stub-setting in progress.

5. Construction of pier.

When all the wells have been sunk to the required depth, the wells are plugged with concrete at the bottom for about five feet, then sand is filled in and again concrete is put in at the top for a depth of about three feet. The capping slab is next laid over the wells with the reinforcement rods of the wells bounded on to those of the capping slab. The pier is then concreted over the capping slab in stages. The main reinforcing rods of the pier are usually connected to those of the capping slab, before concrete for the latter is laid, so that the entire foundation becomes one homogeneous mass.

The tower stubs are set in position with the aid of theodolite on the pier and concreted. The foundation is then ready for erection of the transmission tower.

6. Conclusion.

The method of laying foundations for towers in river-beds, described above, was adopted on the Krishna River for the Machkund-Vijayavada-

Ongole 132 K.V. transmission line. There are five towers across the river at the point of crossing. Four of them have well foundations, three of 30 feet depth and one of 76 feet depth below ground level. The fifth has only mass concrete foundations 13 feet below ground level.

The spans adopted are 1,900 feet and the towers 138 feet high (double circuit) were made out of indigenous Tata steel at Calcutta and supplied by Messrs. Crompton Engineering Company. The whole work was organised very thoroughly, and fairly mechanised, and consequently it was possible to complete the work in one season itself.

Study of Arc Suppression Coil Operations in Ceylon

By Sri **G. S. RAMASWAMI, B.A., B.E.,**
Divisional Engineer (Electrical).

Introduction.

THE HYDRO-ELECTRIC POWER STATION at Laxapana and the Thermal station at Colombo are linked by a double circuit 66 K.V. transmission line. A schematic diagram showing the principal equipment involved in the transmission net-work is given in drawing attached The 15 M.V.A. delta-star transformers at Laxapana have been provided with arc suppression coils, installed in the 66 K.V. neutrals. The breakers are operated as transformer feeders, i.e., there is no parallelling on the two circuits anywhere at 66 K.V. The de-coupling coil prevents the arc suppression coil of one circuit operating for faults on the other circuit. The main transmission voltage is 66 K.V. and the sub-transmission voltage, 33 K.V. In the course of a comprehensive study of the transmission net-work and system of protection, as an expert under the Colombo Plan, the author carried out a study of the arc suppression coil operations also. The study covered the 66 K.V. circuits, and the suppression coil, installed on the 33 K.V. circuits at the three tap-off stations of Norton, two 66 K.V. neutrals are linked through a de-coupling coil. Under normal operating conditions, the transformers at the sending and the receiving ends and the 66 K.V.

Avissavilla and Padukka, over a period of four years from October 1950, when the Hydro-Electric Station was energised.

General Analysis.

1. *Laxapana Power Station.*—Detailed counter readings were made available only from 15th March 1951 and figures up to 15th September 1954 are given in Annexure No. I. The A.S.C. operations during the period 15th March 1951 to 31st December 1951 are disproportionately large, roughly as much as the figure for the balance of the 3½ year period. It is understood that—

(*a*) arc suppression coils were re-tuned in December 1951, and

(*b*) from January 1951 onwards for substantial periods, the Laxapana-Colombo 66 K.V. lines may have been parallelled at Norton Sub-station, thus making it possible for strokes on one line to be recorded on the other line as well. This may have been responsible for the large number of operations observed during this period. The Norton line was normally fed from No. 1 and from the latter part of 1952 onwards the 33 K.V. Peradeniya feeder was running on the same supports on the Norton incoming 66 K.V. line; and for sometime, the Peradeniya line was also linked up with the large 33-K.V. Nuwara Eliya net-work right up to September 1953.

2. *Norton Sub-station.*—The circuit changes are indicated in Annexure III. Prior to 20th September 1953, both the Nuwara Eliya and Peradeniya feeders were fed from one transformer. Thereafter, the No. 1 Transformer normally fed only the Peradeniya feeder, and No. 2 Transformer fed the Nuwara Eliya net-work. After the separation, the transformer feeding the Peradeniya feeder has never tripped.

It is understood that the Nuwara Eliya net-work consists of about 90 miles of 33 K.V. lines, whereas the Peradeniya net-work has about 30 miles of 33/66 K.V. line.

It is deduced from the counter-readings on 12th September 1954, that, up to then, A.S.C. No. 1 and No. 2 have operated 1,212 and 692 times respectively.

Even allowing for the fact that No.1 Transformer has been in service for a longer period, and that No. 2 Transformer was under overhaul for sometime, and allowing also for some fictitious indications representing testing, the number of operations still seem somewhat excessive. This is true to a lesser extent of the A.S.C. No. 2 as well.

Detailed records that are available for the period 6th June 1954 to 12th September 1954 were analysed. During the period A.S.C. No. 1 and No. 2 have operated on fault 13 and 151 times respectively. Of the 151 operations recorded on A.S.C. No. 2 during the period under review, 39 relate to operations on a single day—6th July 1954, when there was a failure due to a tree on the line and 21 on another fault on 1st August 1954. There may have been intermittent earths during this period. Deducting such operations due to known faults there are still 55 operations over a period of a little over three months. It is doubtful if all these operations represent lightning strokes. The 33

K.V. net-work associated with this A.S.C. is understood to be over 90 miles with a large number of transmission stations and spur lines. The possibility of switching operations accounting for a few of these cannot be overlooked. Typical tests, subsequently carried out, have established that a substantial number of the A.S.C. operations at Norton Sub-station are actually due to switching.

It seems also reasonable to assume that some of these A.S.C. operations are due to intermittent earth faults, which ultimately clear themselves, by branches of trees or other shorting pieces, etc., falling down. Also there might have been intermittent, earths due to punctured insulators.

The A.S.C. at Norton Sub-station seems to be definitely out of tune, having regard to the net-work, connected to the transformers. It is not, therefore, surprising that on practically, every occasion there has been trippings, the A.S.C. has also acted indicating that the trippings, some of them at any rate, were caused by inefficient A.S.C. operation. A detailed co-related study of trippings and A.S.C. operations is made out separately below. The better performance of the Peradeniya feeder is to some extent accounted for by the fact that this 33 K.V. feeder is much shorter and its insulation level is much higher being meant for 66 K.V. line.

3. *Avissawella Sub-station.*—The station was energised in July 1953. Only one transformer is in service. The length of the 33 K.V. line fed from this transformer is 18·5 miles. The total number of outages up to 15th September 1954 on the line is 11, three of them due to known faults and the balance probably due to lightning or other passing faults.

Relay indications were not reported. The A.S.C. counter-readings corresponding to trippings have not been observed.

4. *Padukka Sub-station.*—The station was energised on September 1953. The transformers are in service, each feeding 33 K.V. lines independently. The transformer No. 1 feeds a 33 K.V. feeder about 4·5 miles long. Transformer No. 2 feeds a 33 K.V. net-work, 56 miles long including two miles of underground cable which can be linked up with the 33 K.V. outdoor sub-station.

The A.S.C. No. 1 has operated only once. It is understood that the single operation was due to known fault and not to lightning. The A.S.C. on the other transformer was removed from service and substituted by another which had no counter attached. In the circumstances, no co-relation of trippings to A.S.C. operations is possible.

There were 38 outages during the period November 1953 to September 1954. It is reported that 5 of these are due to known faults, 20 due to lightning and 13 due to causes unknown, probably other passing faults. It is possible that some proportion of this last category was also caused by lightning. On only two of these occasions were there relay indications on all three phases.

Co-ordinated study of A.S.C. Operations and Trippings data.

A tabular statement showing the co-relation of A.S.C. operations to trippings on the 15 M.V.A. transformers at Laxapana is given in Annexure No. II. A similar statement in respect of Norton sub-station is also given in Annexure No. III.

1. *Laxapana/Colombo* 66 *K. V. circuits.*—It is possible that some of the A.S.C. operations represent switching operations only and also some may be due to faults not directly on the 66 K.V. network. Again, some of the trippings, not accompanied by A.S.C. operations, may not be phase faults at all on the 66 K.V. line, but merely faults on the 33 K.V. network reflected on the 66 K.V. line as phase faults.

The data in Annexure No. II is therefore to be read, subject to the above remarks. The ratio of ground faults to total faults during the period under review was 81·3 per cent for No. 1 and 70·7 per cent for No. 2 in 1953 and the ratio of successful A.S.C operations to ground-faults was 76·9 per cent and 83·3 per cent respectively. The corresponding figures for 1954 (part year) are 74·3 per cent, 52·7 per cent, 81·3 per cent and 80 per cent, respectively.

The number of A.S.C operations during 1953 was 13 on No. 1 line and 12 on No. 2 line. In 1954 up to 15th September 1954 the corresponding figures were 26 on No. 1 and 10 on No. 2. It is interesting to note that, while the figures on No. 2 for 1954 are approximately on the same level as during the previous years, there has been a large increase in the A.S.C. operations on No. 1 line. There seems to be little evidence to indicate that the No. 1 line is more susceptible to lightning flashovers than the No. 2 line.

2. *Trippings and total fault incidence.*—Trippings accompanied by A.S.C. operations were three each line in 1953. In 1954, the corresponding figures are 6 and 2. Here again, while in the case of No. 2 line, the 1953 levels are being maintained, there has been a substantial increase, in 1954, on No. 1 line. On No. 2 line, the total "fault" incidence in 1953 was 17 and in 1954 (part year) 19, whereas in the case of No. 1 line this jumped from 16 in 1953 to 35 in 1954 (part year). In both cases, the increase may be attributed largely to the increased interference from the tap off lines. The Aviwella and Padukka sub-stations were energised in the latter part of 1953. There is no evidence to prove that the lightning frequency in 1954 was substantially greater than in 1953.

3. *Assessment of arc suppression coil operations.*—The ratio of arc suppression coil operations not accompanied by trippings to total fault incidence is a measure of the effectiveness of arc suppression coils in preventing outages. This was 62·5 per cent on line No. 1 and 59 per cent on line No. 2. In 1954 (part year), these figures went down to 58 per cent for line No. 1 and 42 per cent for line No. 2. The reasons for this fall seems not so much increased inefficiency of arc suppression coil operations but principally, deficiency of the protection schemes.

Arc suppression coils are ineffective on phase-faults. To get a measure of the range of faults over which the arc supperssion coil is ineffective, the ratio of phase fault trippings to ground-fault trippings were also worked out. This rises from 1 in 1953 to 1·5 in 1954 in the case of line No. 1 and from 2·5 in 1953 to 4·5 in 1954 in the case of line No. 2. The increase indicates the reduced scope of arc suppression coils in preventing outages. Also, while large number of ground faults affected one line only, and caused interference only to intermediate loads, the phase-faults are to an increasing extent causing interruptions to terminal supplies. The necessity for taking other measures to improve continuity of supply need hardly be emphasised.

4. *Simultaneous arc suppression coil operations.*—There were two occasions (three operations twice on one incident) in 1953, when the arc suppression coils on both circuits operated together and none in 1954. This may not necessarily mean that both circuits were simultaneously affected by lightning on these occasions. The above figures may be taken more as limits of the probable frequency of simultaneous flashovers on both circuits. No breakdown on fault has been reported on the 66 K.V. main line, since it was energised in 1950. The question of maintaining continuity of supply with faults to ground on separate phases on each line seems therefore only of academic interest. On multiple transmission circuits, therefore, the effectiveness of A.S.C. operations is primarily of interest only in so far as the continuity of supply to intermediate loads is concerned. The same objectives could perhaps be achieved by other methods, such as sectionalised operation of the main transmission lines. In this connection, the remarks of Mr. Marshall of the Central Electricity Board in Great Britain in suggesting limitation of the arc suppression coil installation to circuits up to 33 K.V. may be of interest.

5. *Co-relation of Fault Incidence to Isokeraunic Levels.*—The Isokeraunic level of the area seems to have been assumed as 40. The observed field data however seem to indicate that the actual figures may be nearer 60 corrected for tropical conditions. For this level, tower and conductor configurations and insulation levels adopted, the outage probability based on American experience works out to about 8, if tower footing resistances could be reduced to an average of 20 ohms. The laying of counter poises brought down the tower footing resistances to about this figure for the majority of towers.

The actual outages were however far more than the anticipated figures in 1953 and nearly twice in 1954. This seems to indicate that the actual resistance on the flashover discharge circuit is probably a much larger figure and is increasing. One of the contributary causes to this increase is earth contact resistance. The maintenance of contact resistance at low levels is essential, if full benefits are to be derived from the valuable work done in reducing footing resistance.

6. *Norton Sub-station.*—The period of observation is too short to come to any conclusions, especially as the comparative data in respect of other 33 K.V. networks, where also are

suppression coils have been installed is not available. It is rather unfortunate that the only place, where some detailed data are available, is a place, where the coils are definitely out of tune. In the circumstances it is difficult to arrive at any reliable figures of outages, caused due to lightning only. The important differences between the outage pattern on the 33 K.V. circuits and the 66 K.V. circuits is the greater vulnerability of the 33 K.V. lines to faults, other than lightning, and the fact that the 33 K.V. circuits covered by arc suppression coils are mostly single circuit lines.

Bad effects of coils being out of tune are obvious. This may itself be the cause of some of the observed flashovers. At this sub-station, there have been no trippings unaccompanied by A.S.C. operation. The performance of coils especially at all sub-stations, where properly tuned coils are used, indicates that they have been quite useful in minimising outages.

7. *Conclusions.*—(1) The ratio of total trippings to A.S.C. operations is increasing. On No. 2 circuit in 1954, so far, the trippings have been actually greater than the number of A.S.C. operations. This does not, however, appear to be due to any increase in inefficiency of A.S.C. operations, but due to other factors not coming within their scope.

(2) The ratio of phase-fault trippings to ground-fault trippings is also increasing.

(3) The probability of both circuits being simultaneously affected is small.

(4) The probability of all three phases of a circuit having simultaneous power flashovers due to lightning is also small.

(5) The evidence seems to indicate that the isokeraunic level is more than 40 perhaps near to 60.

The 66 K.V. lines run through typical hill country subject to lightning and the conclusions are relevant for Indian conditions also, especially for lines emanating from Hydro Stations.

(6) On the single circuit 33 K.V. lines, the arc suppression coils have been quite useful in minimising interruptions to supply.

ANNEXURE No. 1.

General analysis of operations of the Arc Suppression Coils at Laxapand Power House.

Date.	Operations of A.S.C. No. 1.	Operations of A.S.C. No. 2.	Circuit changes.
(1)	(2)	(3)	(4)
			30th October 1950.—15 M. V. A. Transformer No. 1. A.S.C. No. 1 ; and 15 M. V. A. Transformer No. 2. A.S.C. No. 2 energised. Tap Positions—Initial— A.S.C. No. 1. (Tap No. 4) 15 Amps. A.S.C. No. 2. (Tap No. 4) 15 Amps. Decoupler Coil—55 Amps (Tap No. 4).
15th March 1951 .. } 31st December 1951.. }	57	35	22nd February 1951—66 K. V. Norton line No. 1 energised. 18th July 1951—66 K. V. Norton line No. 2 energised. 18th December 1951—A. S. C. and Decouplers re-tuned. Present Tap positions— A.S.C. No. 1 Tap No. 5–13·3 Amps. A S.C. No. 2 Tap No. 7–10·0 Amps. Decoupler Coil—Tap No. 6–4·6 Amps.
1st January 1952 .. } 31st December 1952.. }	13	13	....
1st January 1953 .. } 31st December 1953.. }	13	12	66 K.V. No. 1 Norton line kept on Colombo/ Laxapana No. 1 line (normal position). 66 K.V./33 K.V. Avissawella sub-station energised on July 1953. 66/33 K. V. Padukka sub-station energised on 29th September 1953. 66/33 K.V. Both Avissawella and Padukka put on line No. 2 (normal conditions). 66 K. V. Interconnector O.C.B. at both ends normally kept open.
1st January 1954 .. } 15th September 1954. }	26	10	6th August 1954—Peradeniya 33 K.V. feeder taken through and utilised for charging Peradeniya feeder (Test charge only not on load).

ANNEXURE No. 2.

Co-related study of A.S.C. Operations and trippings at Laxapana Power Station.

Serial number.	Details of operations and trippings.	Year. 1953 I	1953 II	1954 I	1954 II
(1)	(2)	(3)	(4)	(5)	(6)
1	A.S.C. Operations accompanied by trippings.	3	2	6	2
2	Trippings not accompanied by A.S.C. Operations.	3	5	9	9
3	Total	6	7	15	11
4	Total A.S.C. Operations	13	12	26	10
5	A.S.C. Operations not accompanied by tripp ngs.	10	10	20	8
6	Total fault incidence	16	17	35	19
7	Ground fault by total fault	81·3%	70·7%	74·3%	52·7%
8	Phase fault by total fault	18·7%	29·3%	25·7%	47·3%
9	Successful A.S.C. operations	62·5%	59·0%	30·0%	42·0%
10	Phase fault by ground fault trippings ..	1	2·5	1·5	4·5

ANNEXURE No. 3.

Co-related study of A.S.C. Operations and trippings at Norton Sub-station for the period 6th July to 15th September 1954.

Serial number.	Details of operations and trippings.			Circuit changes.
(1)	(2)			(3)
1	A.S.C. No.—	I	II	
2	A.S.C. Operations accompanied by trippings.	..	10	1951—Transformer No. 1 and No. 2 energised.
3	Trippings not accompanied by A.S.C. Operations.	..	..	1953—Transformer No. 2 fed Neewara Eliya.
4	Total trippings	..	10	..
5	Total A.S.C. Operations	13	151*	A.S.C. Tap position—
6	A.S.C. Operations not accompanied by trippings.	13	141	A.S.C. No. 2., Tap 3—6 Amps. A.S.C. No. 2., Tap 3—6 Amps.
7	Total fault incidence	13	151*	..
8	Ground fault by total fault ..	100%	100%	..
9	Successful A.S.C. Operations by total number of faults.	10%	33·5%	..

* Includes 86 repeated fault operations.

A Note on Neyveli Lignite Project

By Sri S. RAMAN, B.E. (Hons.),
Assistant Engineer (Electrical).

THE CENTRAL GOVERNMENT have recently sanctioned the project of mining lignite at Neyveli, South Arcot District, under the Second Five-Year Plan. Orders for the earth-moving and special mining machinery, required for the Project have been placed by the Central Government. The mining Scheme has been planned, and programmed, in consultation with Messrs. Powell Duffryn Technical Services, Limited, of the United Kingdom. The completed Project has been envisaged as an integrated Scheme, comprising of mining, processing and utilisation of lignite. A thermal power station is also planned to be established, and necessary action in this regard, is being taken by the Ministry of Irrigation and Power. The power plant of 200 M.W. capacity, that is proposed, would make a substantial contribution, in the stabilisation of electric supply in the State Hydro-Electric Grid. This is the first time that a project of such vast potentialities is being started in the South. An idea of the scope, history, and potentialities of the Project would under the circumstances be of general interest to the readers and a brief description, thereof, is given below :—

History of investigation

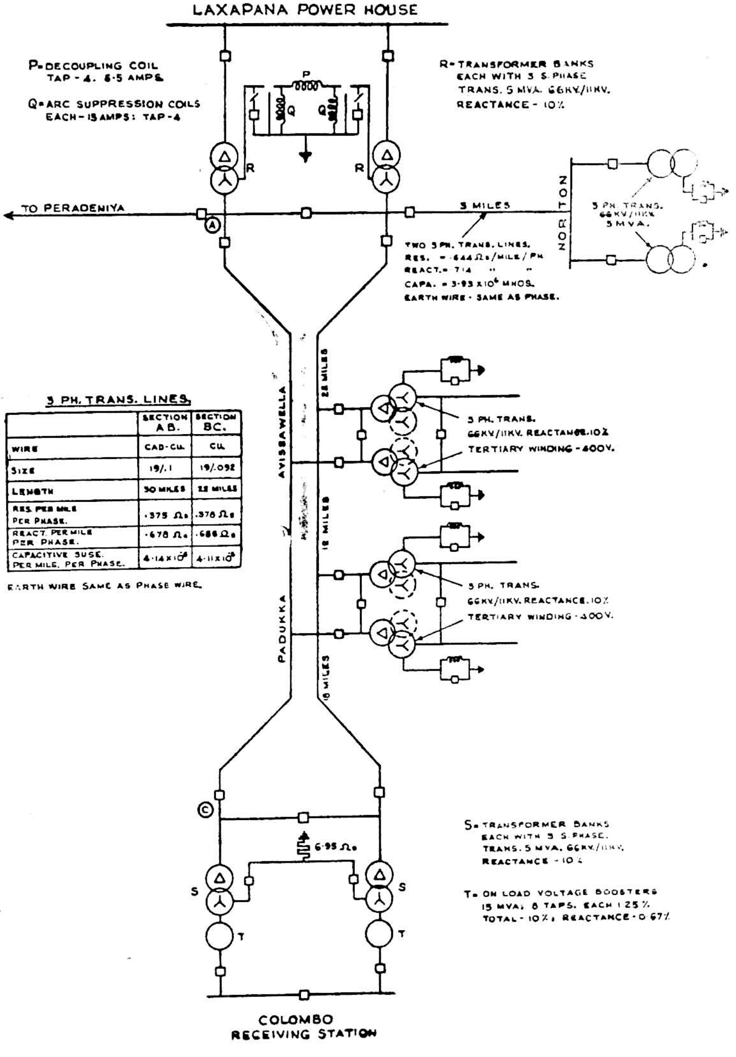
Lignite at Neyveli was accidentally discovered, while boring an artesian well in the early thirties. Regular survey and investigation, of its area of occupation, thickness of layer, quantity availabale for economic exploitation, nature of overburden and under-side material, was however initiated only in 1942. The State Government conducted investigations, carried out pilot excavations and undertook experimental quarrying work till end of 1954.

During the investigations, a number of experimental bore-wells were sunk throughout the area ; and one large ten-foot diameter well was also sunk successfully in the portion of the field, lying on the north of the Cuddalore–Vridhachalam rail-line ; and about 60 tons of lignite were carefully cut off the top portion of the lignite seem, and hauled up for bulk sample tests. A sectional view of this well is shown overleaf.

Bore-well sectioon view

Some assistance for the investigation was also obtained from the Technical Co-operation Mission of U.S.A. by the State. The investigations gave encouraging results, the excavations proved successful and feasibility of mining lignite, and its utilisation in associated, thermal-electric, synthetic fuel and carbonisation plants was established beyond doubt. The State Government also started one pilot scheme, involving open excavation on a 600 feet square plot, sloping down and exposing an area of 100 feet square, at lignite level for open

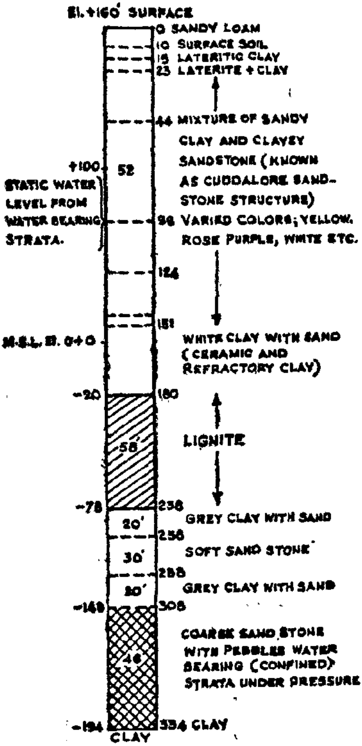
LAXAPANA - COLOMBO
HYDRO - THERMAL SYSTEMS.



3 PH. TRANS. LINES.

	SECTION AB.	SECTION BC.
WIRE	CAD-CU.	CU.
SIZE	19/.1	19/.092
LENGTH	30 MILES	22 MILES
RES. PER MILE PER PHASE.	·375 Ω	·376 Ω
REACT. PER MILE PER PHASE.	·678 Ω	·686 Ω
CAPACITIVE SUSE. PER MILE. PER PHASE.	$4{\cdot}14 \times 10^{6}$	$4{\cdot}11 \times 10^{6}$

EARTH WIRE SAME AS PHASE WIRE.



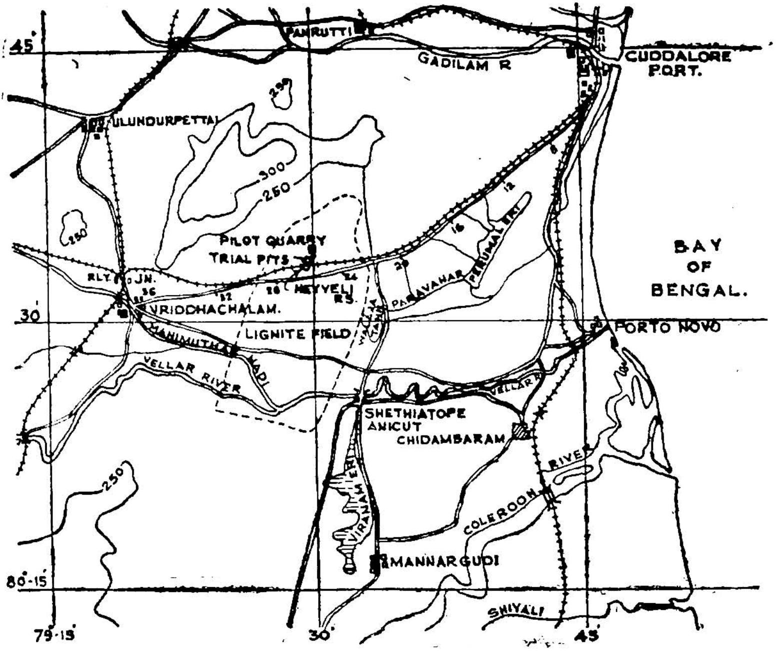
BORE HOLE SECTION

mining. This quarry is expected to yield 20,000 tons of lignite. Serious set backs to excavation work were anticipated from water percolation from surrounding rivers, but in actual execution the clayey soil on the side slopes got dried up on exposure, and formed an impervious layer, preventing percolation, and the work could proceed without dislocation.

At this stage, with the excavation work in progress, the State Government prevailed upon the Central Government to take charge of the entire project. The Central Government accepted full financial responsibility since 1st January 1955, and the Ministry of Production took over direct control of investigation, design and execution of the whole project since 15th of September 1955. The State Government incurred an expenditure of 103 lakhs to end of 1954, and the Central Government an expenditure of even a higher figure, since then to date.

One Chief Executive Officer with headquarters at Madras is in control of the field staff and complete administrative set up. The field staff of engineers, chemists and other workers are under the direct supervision and control of a General Superintendent. There is also a Project Co-ordinating Committee consisting of six representatives of the Central Government, of which the Chief Executive Officer is one; and two representatives of the State Government. This Committee is in general charge of the investigations and makes its recommendations to the Production Ministry on all matters concerning the integrated Project. The Project Committee is assisted by a Standing Committee of Technical Experts, consisting of technical officers of the State and Central Governments.

In 1954, the Central Government obtained the Services of Messrs. Powell Duffryn Technical Services, under the Colombo Plan, as consulting engineers, to study the experimental and investigation data,



LIGNITE FIELD AT NEYVELI

collected by the State Government and make a comprehensive report. Based on their report, and recommendations, the pumping tests, and further investigations were carried out by the Central Government. The services of the consulting engineers were also extended, to enable them to submit proposals for the initial commencement of mining work and its further progressive development until the production target, contemplated, was attained.

Formation of lignite.

Lignite is formed from vegetable matter by bio-chemical decay, happening over a period of millions of years, within the bowels of the earth, just in the same way as peat and coal are formed. It is surmised, that in the early geological ages, large quantities of plant and vegetable matter, left to bacteriological decay, got covered up by the earth's crust, and deposition of soil. In gradual stages, the high pressure of the growing crust of

soil, resulted in the consolidation and dehydration of wood into lignite in the course of some milleniums. The age of the lignite deposits at Neyveli, is estimated to be between 15 and 20 million years.

Extent of availability.

It is estimated that a total quantity of about 2,000 million tons of lignite are available at Neyveli over a roughly rectangular area, nearly 17 miles long and 6 miles wide, about 100 square miles in extent. The lignite is found to occur at depths varying from 160 to 250 feet below ground level. The thickness of the lignite seam is anything from a few feet to about 90 feet and the average thickness is about 55 feet.

The lignite field is bounded on the north by the river Gadilam, on the west by river Manimuthar, and on the south by the river Vellar. The Cuddalore-Vridhachalam railway line cuts through the field. The northern portion has an area of 14 square miles and is estimated to contain about 400 million tons of lignite out of the total quantity of 2,000 million tons. The southern portion has an area of 86 square miles and is estimated to have the balance deposit of 1,600 million tons.

Artesian aquifers.

At Neyveli, a number of artesian aquifers, or water bearing sand strata are found below the lignite bed, and these have been found utilised to some extent for surface irrigation in the southern half of the field, where a number of artesian wells are in service with a continuous output from a few hundreds to as much as 1,500 gallons per minute. The upward thrust exerted on the lignite by the artesian aquifers is balanced by the weight of the lignite and the overburden above it.

Nowhere else in the world is lignite known to occur with a number of very high artesian pressure aquifers below, as at Neyveli, and the unique feature of its occurrence, here, is both a problem and a blessing. If the overburden is removed without eliminating the upward thrust of the artesian aquifers, the artesian water may break through the lignite and flood the mine, men and mining machinery. The pressure on the lignite seam has to be reduced, and the level of the water table drawn down before successful quarrying becomes possible. But the water is available in such large quantity, that, it can very well meet in full the immediate requirements at site for the thermal and processing plants ; and the surplus left over could be stored in the existing irrigation tanks and utilised for irrigation purposes.

Experimental tests.

The upward thrust on the lignite, due to the artesian aquifers is estimated to be 6 to 8 tons per square foot. To permit safe mining it is not necessary to pump out all the water below the lignite , which may, indeed, be a difficult proposition. But the water table at the site of work and in the vicinity has to be lowered to a depth sufficiently below the base of the lignite for safe mining. To determine the feasibility of creating such localised depression

of the water table, experiments were conducted with small capacity pumps in a few bore holes, encased with steel pipes and the reduction of water level obtained thereby was studied. The study of collected data showed that a drawdown of the water table in the mining area by pumping was quite possible.

Full scale pumping tests.

As it would be unwise to decide on the rate, duration and extent of pumping needed for safe mining, on the basis of experimental data obtained with a few small capacity pumps, it was considered desirable and essential to carry out a full scale pumping test and actually lower down the water table to a level of about 50 feet below the lignite seam.

The capacity of the pumps to be used, the number of bore holes to be drilled, etc., were determined from the experimental data collected. Drills were obtained from U.S.A. and deep well submersible pumps from Germany. A few turbine pumps obtained from U.S.A. were also used. On the whole 29 pumps were used for the test in two rows of 14 each and one between the two rows at the end. The distance between the wells was 100 feet and between the rows 250 feet.

The bore holes were made approximately 400 feet deep. The holes were drilled in stages and encased for the entire depth with 16 and 18 inches internal diameter steel pipes. The portion of the steel pipes within the water bearing strata was slotted to permit easy flow of water into the casing from the aquifers. The annular space between the bore-walls and the casing was filled with gravel to prevent sand from entering the casing and also to enable easy flow of water into it. The wells were then freed of mud and sand, and developed to ensure free and continuous flow of water from the aquifers. A number of observation holes were dug to the same depth as the pumpwells, around and in the vicinity of the grid, and water level within the wells, noted from time to time, as the pumping progressed. A few automatic recorders were also installed to give a continuous record of the water level, and two of these were used in the centre of the grid.

The result of tests conducted clearly proved that the water table could be lowered to a level of 50 feet below the lignite seam and maintained at that level, while the mining was in progress.

Analysis of lignite.

Small samples of lignite have been analysed and it is found to contain about 50 per cent of moisture. Dry lignite contains

Carbon—65 to 70 per cent.

Oxygen—20 to 25 per cent.

Hydrogen—5 per cent.

Nitrogen and Sulphur—1·5 per cent.

The lignite on being burned leaves and ash of about 3 per cent. The calorific value of dry lignite is 10,000 B.Th. U. per pound.

A bulk sample of 30 tons, taken out of the experimental pit was sent to the German analysts, Messrs.

Lurgis for complete analytical tests and also for the determination of the optimum conditions for its carbonisation.

Scope of the scheme.

Lignite can be used in the raw state. But it would be most uneconomical to do so. It is desirable to process the lignite before use. Such processing involves briquetting of raw product and subsequent carbonising of the briquettes. The carbonised briquette unlike the raw product gives no smoke and is a valuable domestic and industrial fuel. The volatile carbonisation products can be made to give up tar and from the tar, by hydrogenation under proper conditions can be obtained, other products like diesel oil and petrol. Also valuable substances like pitch, wood preservatives, phenol, and disinfectants would be obtained as by-products.

Although the fundamental part of the scheme proposed and sanctioned is the development of the mines, the project has been integrated with a power plant, fertiliser plant and a briquetting and carbonising plant, to enable economical utilisation of lignite. As coal is now imported from North India for the Basin Bridge Power Station covering a distance of over 1,000 miles, its cost at the station is high due to transport freight. While the Bengal coals have calorific values ranging from 11,900 to 12,300 B.Th.U. per pound and ash contents, varying from 16 to 20 per cent, the dry lignite has a calorific value of 10,000 B.Th.U. per pound, and an ash content of three per cent. The calorific value of lignite is reasonably good, the ash content is low and the use of lignite in the dry form, in the form of carbonised briquettes, would be very economical in a thermal plant.

The quantities mined, in the initial periods will be small and the mine will have to be gradually developed to full capacity. Commercial quantities of lignite are expected to be available from January 1960 when the first thermal unit is expected to be commissioned. The briquetting plants are expected to go into production by June 1960 and the fertiliser plants by about January 1961. Mining the full quantity of about 3½ million tons, required for the whole scheme, will be reached by about July 1960.

The capacity of the thermal power station that is proposed is 200 M.W. The capacity of the fertiliser plant will be 70,000 tons of fixed nitrogen per annum and that of the carbonisation plant will be three quarters to one million tons of carbonised lignite.

Project costs.

The complete project, as envisaged is estimated to cost Rs. 68 crores and with this expenditure it should be feasible to mine 3½ million tons of lignite per annum and to utilise it in the component plants. Against this, provision has been made for the expenditure of Rs. 52 crores in the Second Five-Year Plan and hence practically the entire scheme is expected to be working in full swing by the end of the Second Five-Year Plan.

Preliminary work.

All the preliminaries, with respect to the starting of the project, are completed. Land sufficient for mining over a period of 40 to 50 years is proposed to be acquired for the present.

Mining will be initially earned out in the Northern portion, containing 400 million tons of lignite. Here an area considered most favourable in the locality, and estimated to contain about 200 million tons of lignite has been selected for starting mining operations. A detailed programme for the commencement and development of each item of the project has been worked out.

Scope for further industrial development.

The lignite has been found capable of being carbonised to obtain a satisfactory variety of coking material. East Germany has developed a low shaft furnace, for producing steel, using an inferior type of coke, obtained from their lignite. The Neyveli lignite is found on tests conducted at Germany to be in no way inferior to the German lignite. Iron ore is availabe at Salem. It is found to occur as magnetic oxide mixed with about an equal quantity of silica, and the ore can be concentrated to 95 per cent purity by magnetic attraction. It is expected that the lignite coke could be used in a suitaple low shaft furnace for smelting Salem iron ore and large quantities of iron produced. Installation of an iron and steel plant at Salem is a distinct feasibility.

Certain strata in the Neyveli area are found to be ballclay and china-clay of very good quality. White china-clay with about 40-45 per cent alumina is generally found to occur 20-30 feet thick, mixed with silicious material, immediately above the lignite bed. It is expected that a ceramic industry manufacturing firebricks, stoneware pipes, electrical insulators and crockery would be an economical proposition.

With cheap and abundant thermal power, available at Neyveli exploitation of bauxite mines at Yeracaud, Salem, and establishment of an electro-chemical industry for the production of aluminium is also distinctly feasible.

Conclusion.

The potentialities of the Lignite Project are immense in that the mining scheme is integrated with processing, power and fertiliser industries. The Madras grid is now largely dependent on the H.E. stations of Pykara, Mettur and Papànasam for its supply. The Madras Station contributes about 15 per cent alone to the grid. Continuous deficiency of monsoons over a six-year period 1947 to 1953 has demonstrated the necessity of good thermal back-up to the grid supply. The 200 M.W. station at Neyveli would offer the much-needed support and help to stabilise the grid supply. Neyveli is about 110 miles from Erode, 100 miles from Salem. 120 miles from Madras and 150 miles from Madura. Its location is quite suited to give such stabilisation. The thermal station would also enable further utilisation of the seasonal irrigation flows of mettur dam,

where the existing H.E. station hardly utilises more than 15-20 per cent of the total irrigation flows. A separate 200 M.W. station on the right flank of the dam, involving tunnelling through F-saddle has become a feasible proposition due to the stabilisation of supply expected from the Neyveli Thermal Scheme. Vast expansion of electric supply can be confidently expected in consequence.

With the ceramic and synthetic plants installed and commissioned, the locality around Neyveli may easily become a great industrial centre in South India. If the aluminium and steel plants and allied industries also materialise at Salem, the whole district would be pulsating with industrial activity. Cheap diesel oil, petrol and carbonised briquettes would have favourable repercussions on other industries as well, and the standard of living of the entire population in the State, and neighbouring States too, would receive good impetus in consequence. Availability of aluminium and steel may help rapid industrialisation, and extension of electricity to every village in the State, and usher in an era of economical prosperity to the whole of South India.

Progress During the Quarter Ending 31st March 1956

Salient Features.

The operation and maintenance of all the systems were satisfactory. Water was let down from Mukurti reservoir to keep up the level in Pykara reservoir. The inflows in all the hydro reservoirs were poor and the storage position not quite satisfactory.

The Department earned a revenue of Rs. 187 92 lakhs during the quarter. The working expenses amounted to Rs. 96·95 lakhs. The capital expenditure incurred during the quarter was Rs. 478·58 lakhs, the increase being due to acceleration of construction works.

Supply was given to 2,904 agricultural, 389 industrial, 8,753 domestic services during the quarter. The number of villages electrified during the quarter was 369. H.T. and L.T. lines amounting to 4,509 and 966 miles respectively were erected and energised during the quarter.

Construction Branch.

Madras Plant Extensions.—Under the I Stage Extenstions, all equipments had been erected and were in service except for the mulsifyre protection.

Under the II Stage Extensions, Turbo set No. 1 was recommissioned on 4th January 1956 after the repaired H.P. shaft was received from U.K. All main columns, girders and beams of the boiler house extension were erected. The firing floor in the chimney annexe portion was completed. The work on the roof of the chimney annexe, boiler house and conveyor house was nearing completion. Grouting of the foundation bolts of boiler No. 5 stanchion was completed and preliminary work for the erection of boiler No. 5 and work on superstructure of boiler house extension was commenced.

Under the III Stage Extensions dismantling of foundation of the 'A' station to accommodate the III Stage was in progress. Pile driving was continued. A total of 536 piles were driven till the end of the quarter. The realignment of the South section goit work was completed. Work on cable trenches and R.C. shaft for the bolier house area was in progress.

Pykara Plant Extension III Stage.—All works relating to the Pykara dam had all been completed except for the erection of the spillway gate, which was under good progress.

Periyar Hydro-Electric Scheme.—The lands to be handed over to the Department were being surveyed by the Forest Department. Roads to surge shaft, power house and upper camp were all completed. Road to valve house in steep rocky terrain was progressing.

In the forebay dam, excavation of foundation was nearing completion. About 90 per cent of tunnelling and about 50 per cent of excavation in pipe tunnel were completed. Sinking of surge shaft was completed. With respect to the second stage works, erection of an additional shaft in the irrigation tunnel was completed and enlargement of existing irrigation tunnel was commenced on 1st March 1956 after irrigation closure.

Levelling of tail race was completed. Excavation for foundation in power house was progressing. Excavation in diversion channel and grading of pen-stocks were in progress.

Transmission Lines—1. *Salem-Namakkal* 110 *KV line.*—The construction of the transmission line had been completed. Erection and painting of 110 KV structures at Rasipuram and Namakkal and construction of inspection bungalow at Salem were completed. Construction of quarters was progressing at Rasipuram and Namakkal Sub-stations.

2. *Singarappet-Villupuram* 110 *KV line.*—Excavation, stub setting, tower erection, stringing of conductor and earthwire had been completed for Singarappet-Tiruvannamalai section. Similar works were completed for Tiruvannamalai-Villupuram section. Painting of towers was in progress. Construction of quarters at Villupuram and Singarappet was progressing. R.C.C. foundation structure work at Villupuram sub-station were progressing;

3. *Singarappet-Vellore* 66 *KV line.*—Tower erection was nearing completion, and stringing of earth-wire and conductor and earthing of towers were in progress. The construction of the control room at Vellore Substation was in progress.

4. *South Kanara Scheme.*—The Hulikal-Mangalore 110 KV line, Udipi-Hiriadka-Karkala and Udipi-Coondapur 33 KV lines were completed except for some minor works. Construction of staff quarters and erection of switchgear were under various stages of progress in all the substations.

5. *Villupuram-Pondicherry* 66 *KV line.*—The line materials had been ordered. Tree clearance work was taken up. Tenders have been called for the construction of staff quarters at Pondy Substation.

6. *Travancore-Cochin State border —Udumalpet* 110/66 *KV. DC line.*—The route of the line was approved by the P.T.C.C. and survey work was completed, Profiles and schedules were prepared.

7. *Periyar transmission lines.*—(i) *Periyar-Theni-Madurai* 110 *KV D.C. line.*—The route of the line was provisionally approved by the P.T.C.C. and survey and tree clearance work completed. Profiles and schedules were prepared and 50 per cent of check survey by the contractor was completed for the Periyar-Theni Section.

(ii) *Theni-Sembatti* 110 *KV. DC line.*—Survey and tree clearances were completed. Profiles and schedules were prepared. Check survey and finalisation of schedules were progressing. Excavation for foundation was completed for about 60 locations.

(iii) *Sembatti-Tiruchi* 110 *KV. D.C. line.*—The route of the line was approved by the P.T.C.C. Survey, profiles and schedules were in progress.

(iv) *Sembatti-Karur* 66 *KV. DC. line.*—The route survey was completed and profiles were prepared. Tree valuation schedules were in progress.

(v) *Sub-stations.*—Works on the various sub-stations of the above lines were in various stages of progress.

Operating Systems

HYDRO SYSTEMS—GENERATION.

The Station peak load, units generated, and system peak load, were as follows :—

Name of System/Station.	Station peak load in M.W.	Units generated in millions.	System peak load in M.W.
Pykara	70·9	92·021 }	71·2
Moyar	36·0	39·531 }	
Mettur	32·4	38·077	69·5
Papanasam	28·0	23·085 }	28·5
Madurai Thermal Station ..	13·2	18·384 }	
Udipi	0·40	0·293	28·5
Total ..		211·391	168·2

The following services were connected during the quarter:—

System.	Agricultural.	Industrial.	Domestic.
Pykara	1,110	168	2,997
Mettur	960	30	1,406
Papanasam	431	52	2,756

Water was let down from Mukurthi reservoir to keep up the level in Pykara reservoir. The inflows in all the reservoirs were very poor and the storage position was not quite satisfactory.

In the Pykara Power House, No. 1 Transformer was commissioned back into service after overhaul and fitting up of the Bucholz relay. Detailed inspection of runners of machines was carried out.

In the Moyar Power House, the annual overhaul of machine no. 2 was taken up and completed.

The Erode-Salem feeder was changed over to 110 K. V. operation on 29th January 1956. Consequent on the extension of 11 K. V. supply to the Shenbagapudur from Puliampatti, the temporary 110 K.V. sub-station at Shenbagapudur was disconnected on 19th February 1956.

HYDRO SYSTEMS—DISTRIBUTIONS.

Pykara System.—The Somanur-Puliampatti 66 K.V. line was energised and the Puliampatti Sub-station was commissioned on 10th February 1956. A 16-mile length of Ingur-Kangayam - Vellakoil 33 K. V. line was charged at 11 K. V. on 31st March 1956. The 33 K. V. line at Gur-olapalayam was energised on 14th March 1956.

Mettur System.—During the quarter, 266 tons of tower materials and 1,041 tons of line materials were manufactured at the Mettur workshops. The out-turn value was Rs. 12·32 lakhs.

Erode-Salem 66 K.V. line was changed over to 110 K.V. Operation. H.T. Supply to M/S Salem-Erode Electricity Distribution & Company, Salem at Panamarathupatti point was effected on 10th March 1956.

Papanasam System.—Rectification of line in the East Ramnad area, damaged in the recent cyclone, was in progress.

H.T. supply was given to the following consumers during the quarter:—

1. Indian Textile Paper Tube Company at Virudhunagar.

2. Sree Meenakshi Mills, Samayanallur.

3. Vee Belt Factory at Kochadal.

4. Coronation Litho Works, Samayanallur.

5. Rumumani Mills, Solaiman.

Thermal Systems.

MADRAS SYSTEMS—GENERATION

The Station peak load, units generated and System peak load during the quarter, were as follows:—

Name of station.	Station peak load in M.W.	Units generated in millions.	System peak load in M.W.
'A' Station.	22·0	30·356	38·6
'B' Station.	29·0	41·203	
Total ..	51·0	71·559	38·6

Also 385 agricultural services, 134 industrial services and 1,498 domestic services were connected during the quarter.

At 'A' Station, boilers 6, 7 and 9 were in satisfactory service throughout the quarter. Boiler No. 8 was put back into service after annual overhaul on 3rd February 1956.

At 'B' Station, boilers No. 1 to 4 were in service throughout the quarter.

MADRAS SYSTEM—DISTRIBUTION

Work on the following 33 KV. lines was in progress :—

1. Pulal-Ponneri.
2. Poonamalle-Avadi.
3. Chingleput-Maduranthakam.
4. Maduarntakam-Nogumbal.
5. Poonamalle-Guduvancheri.
6. Pudhuchartram-Tinnanur.
7. Aranvayal-Kilanur.
8. Kanchee-Wandiwash.
9 Kanchee-Kadambathur.

Besides these, 139 major construction works were in various stages of progress.

During the quarter, 831 D.C. services with a connected load of 833. K.W. were changed over to A.C. on a voluntary basis.

Rural Electrification.

The number of villages electrified during the quarter in the several systems was as follows :—

System.	Number of villages.
Pykara	102
Mettur	93
Papanasam	95
Madras	79
	369

The length of lines erected and energised during the quarter under the various schemes for rural electrification were as follows :—

System.	Length of lines in miles. H.T.	L.T.
Pykara ..	93·66	263·05
Mettur ..	95·78	358·69
Papanasam ..	127·46	232·54
Madras ..	133·09	111·95
	449·99	966·23

Accounts Branch.

The Department earned a revenue of Rs. 187·92 lakhs during the quarter. The working expenses amounted to Rs. 96·95 lakhs.

The capital expenditure during the quarter amounted to Rs. 478·58 lakhs. Increase in the capital outlay during the quarter was due to acceleration of construction works.

The total voluntary loan contributions received in the various systems were as follows :—

System.	RS. (IN LAKHS.)
Pykara	11·00
Mettur	3·84
Papanasam	2·96
Madras	18·90
Total ..	36·70

Technical Branches.

A. Electrical.—Under Periyar Hydro-Electric Scheme, a fresh specification covering the fire protection equipment for the outdoor transformer yard was issued.

Draft specification for generating plant and indoor switchgear for the Kundah Hydro-Electric Scheme was prepared.

Data for net-work analyser studies such as for generating plant, transformers, etc., were checked and revised incorporating all up-to-date modification.

Specification covering the additional equipments at Villupuram and switchgear equipment at Neyveli Sub station was issued.

A total of 176 extension proposals costing Rs. 1·96 crores and nine improvement proposals costing Rs. 0·97 lakh were scrutinised.

B. Civil.—Orders were placed for the supply of spare parts required for the sluice valve at Moyar.

Orders under the Periyar Hydro-Electric Scheme were placed for the supply of new gate, etc., in shaft no. 1 under irrigation tunnel (2) gate, trash rack, pipe in dam, etc.

Tenders for the construction of equipments such as stone crushers, granulators, etc. required for Kundah Hydro-Electric Scheme were finalised.

Various alternatives in the design of tunnels surge shaft, size of penstocks for the Kundah Scheme were examined. Drawings and estimates for certain temporary and permanent buildings for the Kundah Hydro-Electric Scheme were finalised.

Preliminary survey of the Mettur Tunnel Scheme was in progress. Survey of the foreshore of the left flank for determining alternative tunnel route was nearly completed.

Preliminary survey works of Kumbar-Amaravathi Hydro-Electric Scheme was in progress.

Collection and compilation of rainfall and run-off figures of the various basins in this State, under observation by the Department, and rainfall figures obtained from other Departments and private estates were continued. The total number of rainfall stations at the end of the quarter was 523.

The Government Electricity Department in 1954—55

1. *Salient Features.*—The following were the salient features in the administration of the Department during the year :—

(1) The capital expenditure on new projects and extensions under construction totalled Rs. 5·84 crores.

(2) The Periyar Hydro-Electric Scheme was sanctioned and work on the scheme inagurated by the Chief Minister on 11th February 1955.

(3) At Pykara, all the works in connexion with the III Stage Extension of the Power-house were completed and the 6th and 7th generating units were commissioned in June 1954, increasing the installed capacity of the station from 43 M.W. to 70·2 M.W.

(4) At Basin Bridge one 80,000 lb. per hour boiler and one 15 M.W. turbo alternator were commissioned under Madras Plant Extensions Stage II.

(5) Double-line service at 110 KV was effected between Moyar and Erode and between Mettur and Singarappet.

(6) Power demands totalled 181·7 M.W. and energy generated by the Department (including power purchased from Mysore, etc.), amounted to 933·67 million units.

(7) Supply was maintained without any power cuts throughout the year, in the hydro and thermal areas. The generation during the year went up to 760·3 million units in the hydro areas and indicated an increase of 25 per cent compared to the generation during 1953–54 in the same area.

The year under review was a fairly good year, judged from the inflows into the reservoirs of hydro stations. The water position was satisfactory. The Tambaraparni lake level stood at its F.R.L. from 26th December 1954 to 2nd February 1955. This is the first occasion for the lake to stand at the F.R.L. for such a long duration since the dam was built. The Mettur dam was opened for irrigation on 14th June 1954 with the lake level at 768·6 and it was closed for irrigation on 7th February 1955 with the lake level at 743·23. At Pykara Dam (now under construction) storage was built up to 760 feet level and water had to be spilled over as further storage was not possible.

(8) Electricity was extended to 308 villages and towns and 3,460 agricultural pumpsets in the State during the year. The villages and towns electrified and pumpsets connected in the State so far number 2,602 and 24,654, respectively.

2. *Power Demands.*—The aggregate of the power demands on the Government systems was 181,699 K.W. and the units generated 933·67 millions (including power purchased from Mysore, etc.).

Details for the various systems are furnished hereunder :—

Name of system.	System demand in K.W.	Generation in million of units.
I. Hydro-electric—		
1 Pykara	59,800	259·81 + 108·44 (Moyar)
2 Mettur	58,400	245·42
3 Papanasam	26,300	109·30 + 37·32 (Madurai thermal station.)
II. Thermal (Steam)—		
1. Madras	36,500	171·50
III. Thermal (diesel)—		
1 Udipi	232	0·57
2 Karkala	45	0·09
IV. Power purchased from Mysore and other sources—		
1 Kollegal	292	0·86
2 Fort Cochin	130	0·36
Total ..	181,699	933·67

3. *Power Generation—A. Total generation.*—Figures for power generation in the State including licensees are as follows :—

Sources of generation.	*Generation in millions of units.*	*Percentage of total.*
I. Government :		
1 Hydro-electric	722·97	77·08
2 Thermal (steam)	208·82	22·28
3 Thermal (diesel)	0·66	0·07
4 Purchased from Mysore and other sources.	1·22	0·13
II. Licensees (thermal)	4·17	0·44
Total ..	937·84	100·00

The total generation in the State was 937·84 million units against 762·56 million units in the previous year showing a phenomenal increase of 23 per cent over last year.

B. System consumption.—The power demands of the three hydro systems totalled 144·5 M.W. against 120·8 M.W. in 1953–54. The energy generated in the hydro-systems and

the Madurai Thermal Station amounted to 760·3 million units. *Details of power demand and energy generation* are furnished hereunder :—

Name of system or power-station.	*System consumption in millionunits.*	*Station demand in M.W.*
Pykara System } Moyar .. }	300·08	{ 71·7 37·0
Mettur System	330·38	45·5
Papanasam System	134·28	28·0
Madura Thermal Station	..	11·2
Total ..	764·74	193·4

C. Hydro-thermal relief.—The thermal relief availed from Madras by the hydro systems was 36·5 million units, while the surplus exported to Madras by hydro systems during irrigation season was 3,200 units.

D. Madras System.—The peak load of the Madras System reached 36,500 K.W. against 30,600 K.W. in 1953–54. The number of units generated during the year was 171·498 millions against 152·998 millions in 1953–54. There was practically no need for running the 'C' station plant after the 15 M.W. Turboset No. 1 at the 'B' station (under Madras Plant Extension II Stage) went into regular service. The 'C' station was run only for a few days in the year, when increased relief had to be afforded to the hydro-systems or when the coal position warranted running of the station. Madras availed relief from Mettur to the extent of 37·4 million units mostly during the irrigation season, while Madras exported to Mettur 35·53 million units mostly during the non-irrigation season.

4. *Power Utilization.*—Power generated was utilized as under :—

Serial number and use.	Percentage of total power utilised.
1. Industrial supplies ..	59·5
2. Irrigation and agriculture.	14·0
3. Domestic heat, power, lights and fans.	13·0
4. Commercial heat, power, lights and fans.	7·0
5. Public lighting	3·0
6. Traction	1·5
7. Miscellaneous	2·0
Total ..	100·0

5. *Load Development.*—As in the previous years, the demand for power for industrial and agricultural purposes continued to be on the increase. Rural electrification works and works on community project areas were in full swing during the year. Due to availability of funds a vigorous drive was made in the matter of electrification of rural areas.

6. *Financial Results* (1954–55).—The gross revenue earned by the Departmental undertakings, in operation, during 1954–55, was Rs. 597 lakhs as against Rs. 481 lakhs in 1953–54 registering an increase of 24 per cent.

Details of capital outlay, gross revenue of the system are furnished revenue, working expenses and net hereunder :—

Name of system.	Year of operation.	Total capital outlay. RS. (IN LAKHS).	Gross revenue. RS. (IN LAKHS).	Total working expenses. RS. (IN LAKHS).	Net revenue. RS. (IN LAKHS).
(1)	(2)	(3)	(4)	(5)	(6)
I. Hydro-electric System—					
1 Pykara Electricity System.	Twenty-Second	1,054·98	176·43	95·26	81·17
2 Mettur Electricity System.	Eighteenth	815·57	141·10	88·30	52 80
3 Papanasam Electricity System.	Eleventh	692·10	75·16	54·24	20·92
II. Thermal—					
1 Madras Electricity System.	Eighth	868·00	204·56	139·77	64·79
	Total ..	3,430·65	597·25	377·57	219·68

7. *Return.*—The return on capital outlay in operating systems worked out to 6·4 per cent net.*

8. *Inspectorate.*—The receipts from the Inspectorate amounted to Rs. 15·42 lakhs made up of Rs. 11·45 lakhs from the Electricity Duty, Rs. 2·65 lakhs from penalty for excess consumption of electricity, Rs. 1·03 lakhs from inspections under the Indian Electricity Act and Cinematograph Act; Rs. 0·20 lakh from royalty for use of Government water for generation of electricity and Rs. 0·09 lakh from fees for audit of licensees' accounts.

9. *Number of Consumers.*—There were 3,57,942 consumers at the end of 1954–55 served by all electrical undertakings in the State including Government areas.

Of these, 353,296 consumers were in the areas served by power generated from Government undertakings of whom 186,750 were served directly by the Electricity Department and the rest 166,546 by licensees distributing Government power. The balance of consumers, viz., 4,646 were served by self-generating licensees. Details are given in the statement below ;—

Name of system.	Number of consumers. Served by the Electricity department.	Served through distributing licensees in Government areas.	Served by other licensees
Area served by Government directely or through licensees—			
I. Hydro-electric—			
1 Pykara	56,715	..	..
2 Mettur	31,991	..	..
3 Papanasam	41,708	..	..
II. Thermal—			
Madras	55,747	..	..
III. Power purchased outside—			
Kollegal	589	166,546	..
Total ..	186,750	166,546	..
Served by self-generating licensees.	..	..	4,646
		Grand total ..	357,942

10. *Extension of Supply.*—Supply was extended to 265 villages and towns by the Department and to 43 villages and towns by the licensees during the year. The total number of villages and townships having electric supply at the end of 1954–55 was 2,386 and 216, respectively. The number of villages supplied by the Department and by the licensees are shown below :—

Supplied by.	Number of villages.	Number of towns.
(1) The Department	1,551	118
(2) Licensees	835	98
Total ..	2,386	216

11. *Transmission and Distribution Lines.*—The route mileage of Government transmission and distribution net-work increased by 1,389 miles during the year. The total miles of high-tension and low-tension lines in each system at the end of the year are furnished below :—

Name of system/circle.	Number of route miles. H.T.	L.T.	Total.
1 Pykara	2,043	2,739	4,782
2 Mettur	1,900	1,373	3,273
3 Papanasam	1,071	896	1,967
4 Madras	546	924	1,470
5 Generation Circle, Erode ..	454	..	454
Total ..	6,014	5,932	11,946

Details of route lengths up to the end of the year of the H.T. and E.H.T. lines are furnished below :—

Line voltage.	Lines constructed during 1954–55.		Total length in miles at the end of 1954–55.	
	Single circuit. MILES.	Double circuit. MILES.	Single circuit. MILES.	Double. circuit. MILES.
(1)	(2)	(3)	(4)	(5)
110 K.V.	..	..	..	25·00
66 K.V.	..	..	102·91	191·00
33 K.V.	9·5	..	9·5	..
22 K.V.	61·91	..	715·74	83·35
13·2 K.V.	Nil	..	4·36	..
11 K.V.	49·52	..	868·81	40·63
Total ..	120·93	..	1,701·32	341·98

12. *Power Transformers and Sub-stations.*—Details of power transformers installed, number of sub-stations, etc., are furnished below :—

System.	66 and 110 K.V.		22 and 33 K.V.	
	Number.	Capacity. K.V.A.	Number.	Capacity. K.V.A.
1 Pykara	14	104,400	3	2,750
2 Mettur	17	102,250	9	15,500
3 Papanasam ..	10	49,400	4	21,500
4 Madras	2	23,000	16	26,650
Total ..	43	279,050	32	66,400

NOTE.—The statement does not include transformers in power-houses.

13. *Rural Welfare Schemes.*—The financial position being satisfactory, work on rural electrification was carried on vigorously. In view of the great importance attached to rural development by the Government of India and Madras, the Centre had promised a loan of Rs. 3 crores from their Special Development Fund for rural electrification to be spent against additional extension schemes not already covered by the Five-Year Plan. The power position being also satisfactory a special drive was made during the year to connect as many villages as possible. The number of villages electrified during the year was 265, which exceeded the target figure of 250 villages fixed for the year.

14. *Construction Activities.*—Construction works connected with the first Five-Year Plan of power development in the State were in full swing, and a total capital expenditure of Rs. 4·78 crores was incurred on major projects and transmission lines.

The following major projects and lines were in progress :—

(1) Pykara Plant Extensions (III Stage).

(2) Madurai Thermal Scheme.

(3) Madras Plant Extensions.

(4) South Kanara Extension Scheme.

(5) Madurai-Tirumangalam-Rajapalayam-Tenkasi 66 KV Line.

(6) Madurai-Sivaganga 66 KV line.

(7) Pykara-Coimbatore-Madurai 110 KV line.

(8) Theni-Sembatti 110 KV line and Periyar-Theni-Madurai line.

(9) Periyar Hydro-Electric Scheme.

15. *New Schemes Sanctioned.*—The more important schemes sanctioned during the year 1954–55 were :—

		Initial cost RS. (IN LAKHS).	Ultimate cost. RS. (IN LAKHS).
1	Periyar Hydro-Electric Scheme ..	675·60	1,047·50
2	Villupuram-Neyveli 66 K.V. Extensions.	5·00	25·49
3	Change over of Erode-Tiruchirappalli *III* Curcuit line to 110 K. V. operation.	18·26	18·26
4	Theni-Sembatti 110 K·V. line and Sub-station (advance construction).	..	31·42
5	Cannanore-Badagara Extensions ..	14·28	19·05
6	Villupuram-Pondicherri Extensions ..	4·00	19·00

16. *Electrical Inspectorate and Licensees.*—The number of licensees, undertakings at the close of the year was 31 (including one sanctioned, operating under Section 28 of the Indian Electricity Act). Of these, seven were managed by local bodies and the rest by private companies.

No new licences were sanctioned during the year. The Kanara Ceramics, Limited, Kasargod, the sanctionee operating under section 28 of the Indian Electricity Act, were permitted by Government (1) to continue supply till 31st March 1956 or till Government supply becomes available to the area, whichever was earlier and also (2) to extend the area of supply in Kasargod Panchayat and also to a portion of the Kudhu Panchayat. There was no other sanction for extension of area of supply or period of licence during the year.

Permission was granted under Section 9 (2) of the Indian Electricity Act to Vellore Electricity Licensee to take mortgage loan of Rs. 6 lakhs from the Madras Industrial Investment Corporation.

The accounts of 21 licensees were audited by the Audit Officer besides three accounts of licensees pertaining to the previous year.

There were at the end of the year 737 cinemas of which 328 were permanent and 409 touring.

The total number of accidents during the year including those on lines owned and operated by Government was 193 of which 62 were fatal.

[*Abstracted from the Administration Report for* 1954–55.—*By Sri S. Raman, A.E.* (*Electrical*).]

General Notes by Editor

1. Accounts of the "Yoganandam Memorial Funds" and disposition of the "Yoganandam Memorial Prize Funds".

The members of the Electricity Department are aware that the "Yoganandam Memorial Committee" was formed in the year 1949, to collect contributions and to decide the best course to perpetuate the name of late Sri Yoganandam. The collections amounted to R. 4,900. The Committee consisted of the following members :—

(1) Sri B. R. Somayajulu—President.

(2) Sri P. V. A. Narayanamoorthy—Member.

(3) Sri A. Venkateswaran—Member.

(4) Sri L. Ekambaram—Member.

(5) Sri A. P. Seethapathy—Member.

On 16th January 1950, the Committee met, and passed a resolution that an amount of Rs. 1,500 be set apart for awarding a prize for the best technical article published in the Madras Electricity Department Journal, and the balance amount of Rs. 3,400 be utilised for setting up a technical library. The amount of Rs. 1,500 was kept in the current account with the Indian Bank, Triplicane; and Rs. 3,400 deposited in the 3½ per cent Treasury Savings Certificates of the Reserve Bank of India.

On 10th April 1951, the Memorial Committee modified the resolution, as regards, setting up of a technical library and decided to utilise the amount for instituting a prize, in the name of Sri Yoganandam in each of the four Engineering Colleges of the State, at the time: viz.

(1) The College of Engineering, Guindy.

(2) The College of Technology, Coimbatore.

(3) The College of Engineering, Anantapur.

(4) The College of Engineering, Kakinada.

The prizes were to be awarded annually to the candidates, who score the highest marks in the B.E.,-University Examination in Electrical Branch. The President was authorised to implement this, in consultation with the Principals of the four Colleges.

After the formation of the Andhra State on 1st April 1953, it was decided by the Memorial Committee, that an amount of Rs. 1,600 be set apart for institution of prizes in the colleges of each State, and that the amount pertaining to the Madras State, be handed over to Sri L. Ekambaram and that pertaining to the Andhra State to Sri V. Pappu. Members may be interested to know, that the money was received by Sri L. Ekambaram in December 1955 ; and he has already made over the amounts of Rs. 800

to each of the two College Principals. He is also in correspondence with the Principals of the Colleges, and the Secretary for Education and Public Health Department, for depositing the amounts with the treasurer of charitable endowments, and to utilise the interest accruing there from for issue of prizes to the best electrical engineering candidates of the two colleges.

After dispersal of the amount for prizes in the colleges the fund accounts stood as under :

	RS.	A.	P.
Total amount collected	4,900	0	0
Interest on Treasury Savings Deposits with the Reserve Bank of India.	493	3	0
	5,393	3	0
Less amount deducted by the Reserve Bank for premature withdrawal of deposit.	204	0	0
Less amount actually handed over to Sri V. Pappu ..	1,598	0	0
Less amount actually handed over to Sri L. Ekambaram.	1,598	0	0
Balance Amount ..	1,993	3	0

It was resolved, further, by the Committee, that two-thirds of the outstanding amount, be handed over to the Editor of the Madras Electricity Department Journal and one-third to the Editor of the Andhra Journal. Accordingly, a cheque for Rs. 1,328–12–0 was received by the Editor of the Journal.

It was decided, to invest the amount in the Madras State loan bonds, and accordingly four per cent 1967 State bonds to the face value of Rs. 1,300 were purchased from the open market. Also a Savings Bank account was opened for the balance amount of Rs. 17–14–6 with the State Bank. The bonds have been deposited with the State Bank for safe custody, and the State Bank have agreed to collect the interest due half-yearly, levying nominal collection charges for their services and to intimate the Chief Electrical Inspector of such collection.

As already explained in the April-June 1956—issue of the Journal, the Yoganandam Memorial Prize Committee consists of—

(1) the Chief Engineer for Electricity.

(2) the Chief Operation Engineer (North).

(3) the Chief Operation Engineer (South).

(4) any other members, co-opted from time to time. The Editor of the Journal is the Secretary of the Committee. The Chief Electrical Inspector to Government, as Editor of the Journal, is the Secretary of the Committee.

The bonds stand endorsed to the Chief Electrical Inspector to Government, in his capacity as Secretary to the Yoganandam Memorial Prize Committee, and he has been authorised to operate on the Savings Bank accounts by the Prize Committee, in the same capacity.

II. The Electrical Licensing Board.

Rule 45 of the Indian Electricity Rules, 1956 (48 of the Indian Electricity Rules, 1937) is coming into force in this State from 1st October 1956.

Under the provisions of this rule "no electrical installation work, including additions, alterations, repairs and adjustments to existing installations, except such replacement of lamps, fuses, switches, low voltage, domestic appliances and fittings, as in no way alters its capacity or character, shall be carried out upon the premises of, or on behalf of any consumer or owner, for the purpose of supply to such consumer or owner, except by an electrical contractor licensed, in this behalf by the State Government, and under the direct supervision of a person holding a certificate of competency issued or recognised by the State Government".

As such, installation works, which have been carried out in contravention of the above rule shall not be connected with the works of any supplier.

For issue of licences and competency certificates, the Government of Madras have constituted "The Electrical Wiremen, Supervisors and Contractors Licensing Board" consisting of seven members including the President and Secretary. The Chief Electrical Inspector to Government is ex-officio President of the Board and the Electrical Inspector is the ex-officio Secretary. The Board office is located at 157, Mount Road, Madras-2.

Even though this rule has been on the statute book since 1937, it was not brought into force till now, as it was thought, that sufficient qualified persons to hold the supervisors' and contractors' competency certificates may not be available in the State. The standard of electrical wiring work in the State, during and after the war, has not been throughout satisfactory, and consequently the number of electrical accidents is on the increase. In view of the urgency to improve the standard of wiring work, Rule 45 of Indian Electricity Rules, 1956 (Rule 48 of Indian Electricity Rule, 1937) has therefore been notfied to come into force in the State from 1st October 1956.

Rule 45 of Indian Electricity Rules, 1956 does not distinguish between temporary and permanent connections and is applicable equally to both. But it should be obvious that actually greater care should be bestowed on temporary supplies, as most of these are for public purposes, or for festival occasions, where large numbers of people are expected to assemble and accidents are more likely to occur.

It is the duty of the distribution engineer to ensure that wiring work of consumers' installations is carried out in a thoroughly safe manner by a licensed contractor and under the direct supervision of competent wiremen. It is therefore necessary, that, before effecting supply to a consumer, the distribution engineer makes quite sure, that the test report of the concerned installati onis signed by the contractor giving the number and date of his licence and of the

competency certificates of the wiremen, under whose direct supervision, the work had been carried out. In case of accidents caused by bad workmanship or non-observance of Indian Electricity Rules, the Board will be enabled to institute necessary action against the contractors and wiremen concerned, if the above procedure is adopted.

The Board has been empowered to enquire into allegations of incompetence, negligence, breach of the Indian Electricity Rules or other malpractices on the part of the any wiremen, supervisors, or contractors, holding a certificate of competency or licence as the case may be.

Contravention of Indian Electricity Rules and misconduct of licensed wiremen, supervisors and contractors can be brought to the notice of the Board for investigation, by the consumer or an officer of the Department not below the rank of a Divisional Electrical Engineer. The distribution engineers are therefore requested to bring to the notice of the concerned Divisional Electrical Engineer, of all lapses, in this regard. The Divisional Engineers should then cause a preliminary enquiry to be made, and if there are reasonable grounds for taking the matter further up, they should bring it to the notice of the Board.

As the rule has been brought into force mainly to ensure satisfactory work and thereby reduce accidents in consumers' premises, it is the duty of all distribution engineers, and the officers of the Department to be vigilant and to extend their fullest co-operation in enforcing the rule.

III. Deputation of the Chief Engineer under the Columbo Plan.

The Dominion of Canada and the United States of America have extensive resources of hydro-electric development. Development in the provinces of Quebec and Ontario in the South-East of Canada is phenomenal and the three important systems of development there are (1) the Shawinigan Water and Power Company; (2) the Quebec Hydro Commission and (3) the Ontario Hydro-Electric Power Commission. These are all inter-connected into a common Grid.

Further South in the United States of America, the Tennessee valley has been developed, and consists of several hydro-electric stations forming a common Grid.

Sri V. P. Appadurai, *Chief Engineer* for Electricity, was awarded a fellowship under the Colombo Plan and was deputed by the Madras Government to go to Canada and U.S.A. to make a study. He has extensively travelled, and made a detailed study of the power stations, and the supply systems he visited. He has published detailed information of his studies in five volumes under the auspices of the Madras Government, with the following headings :—

(1) Power Stations.

(2) Penstocks and Hydraulic turbines.

(3) Generators.

(4) Sub-stations.

(5) Transmission, Distribution and Communication lines.

It is proposed to publish extracts from out of the above publications, from time to time, for the benefit of the readers of this Journal, as space will not permit of reproducing the full information.*

IV. A New Feature.

It has been decided to open a new feature in the Journal with effect from this issue, called the " Problem Corner ", wherein, general, technical, geometrical and mathematical problems, would be published. The Journal Committee felt that an interesting feature of this kind would serve to enliven and enable all the Departmental members to take part in the progress of the Journal. Members are requested to solve these problems and send their solutions to the Editor. The solution, to the problem appearing in this issue should reach the Editor on or before 15th July 1957. Names of members who render correct solutions, would appear in the next issue of the Journal.

It will be realised that this new feature can be kept up, only by the co-operation of the members. The members should not only solve the problems appearing in the Journal, and send their solutions to the Editor, but also suggest new problems themselves for publication. The problems proposed should not have appeared in other journals and should, as far as possible, be original. They should neither be too easy nor too difficult. Problems received would be considered by the Editor, and the Journal Committee, and such of those, found suitable, would be published, along with the names of the authors, who have suggested them.

It is hoped that this new feature would be welcome to all the Departmental members, and that the members would emulate one another not only in solving the problems, but also in suggesting new ones. for inclusion in the Journal.

*An extract on " Rural Electrification Administration " in U.S.A. from Vol. 1 is published under " Technical Press " in this journal.

Technical Press

I. The Rural Electrification Administration.

The Rural Electrification Administration is a federal organization that gives loans to co-operative societies established for promoting rural electrification, on non-profit basis. The Administration works hand-in-hand with co-operative leaders, with the basic principle, that its aid should be given, in such a way, as to promote the ability of the co-operatives, to handle their own affairs effectively, with less and less assistance from the Government in the long run.

Rural electrification as a programme of the Congress was established by President Roosevelt in 1935. By an executive order, he created the Rural Electrification Administration with powers vested in an administrator to "initiate, formulate, administer and supervise a programme of approved projects for the generation, transmission and distribution of power in rural areas." The Authority Act had made $ 100 million available to the President for allocation to the R.E.A. activities and provided for execution of a 10-year programme of promotion by making (2 per cent) interest bearing loans repayable in not more than 25 years, to local interests, so organized, as to make them eligible borrowers of public fund, preference being given to public bodies and to co-operatives, non-profit and limited-dividend associations, organized under State laws.

Two principal problems confronting a group of farm-people deserving to become eligible for a loan for the *construction of a local electric distribution system* were—

(*a*) Proper incorporation and organization under State laws.

(*b*) Demonstration that their project could operate successfully, and repay the loan within the period, originally set at 20 years, and later on increased to 35 years.

A number of subsidiary problems were also involved.

Between 1937 and 1939 the R.E.A. developed an organization and procedure that would enable it to go into the field and guide the applicants' activities from their beginning. Gradually, it assumed the responsibility of sending to farm-people, desiring electricity and requiring loans, various types of specialists, who could advise them on such matters, as effecting a legally adequate organisation, securing an initial and expanded membership, designing a suitable system, negotiating with sources of wholesale power, securing certificates of necessity and rights-of-way, standing for their rights in conflict with commercial companies before commissions and legislatures and, when

legislative authority was indefinite, introducing appropriate Bills in legislatures.

In July 1939, under the reorganisation plan, the R.E.A. ceased to be an independent agency and became a part of the Department of Agriculture, although its administrative integrity was retained. This move promoted more intimate contacts with other agencies, concerned with the welfare of farmers and enabled it to become a social force, helping to mould the culture of rural life.

The R.E.A. organization comprises of the following two divisions :—

(1) Loan Division.

(2) Auxiliary Division.

The Loan Division has four branches: (*a*) The Applications Division, for recommending loans and for guidance to borrowers in preparatory steps.

(*b*) The Engineering Division, responsible for the approval of the designs, inspection of construction, and inspection and approval of the properties that form security for the loans.

(*c*) The Management Division, responsible for advice and assistance to borrowers and general management problems.

(*d*) The Finance Division responsible for audits and accounts of borrowers, receipts of payments, advance of funds and the accounting for transactions with the treasury, other Government agencies and borrowers.

The Auxiliary Division also has four branches as under :—

(*a*) TheAdministration Services Division responsible for communication and records, administrative accounting, and statistical services.

(*b*) The Information Services Division or publications, press and radio service and co-operative education.

(*c*) The Personnel Division responsible for employment of R.E.A. personnel, classification, training, safety and health.

(*d*) Technical Standards Division for the establishment of electric construction and use of standards, electro-agriculture, and new development.

The R.E.A. borrowers are private enterprises just as much as are the commercial companies, but they receive investment funds from and are influenced by a public money source, while the commercial concerns receive investment funds from and are influenced by the private money-market.

In the early period, when the co-operatives were young, inexperienced and struggling against obstacles, it had been necessary to give advice and assistance to all of them and in considerable detail, both in their interests and in the interest of security for the Government loans. But gradually, they were thrown more and more on their own and enabled to become independent enterprises with thier own Co-operatives State Associations, and the National Rural Electric Co-operative Association at Washington.

The Co-operatives do not pay any income-tax because they are non-profit co-operative bodies and have no base to which to apply such a tax. But, in the matter of property and other local taxes, they carry their share as required by the laws of the State.

In 1952, the Rural Electrification Administration approved rural electric loans amounting to more than $ 165 million and made loan allocations of slightly over $ 41 million to rural telephone borrowers. Approximately, 6,000 miles of new line and 73 central offices to serve more than 23,000 rural subscribers were in construction during the year 1952.

By June 30, 1952, 88 per cent of the United States of America farms were receiving central station electric service. Rural Electrification Administration borrowers were serving actually a total of 3,769,000 rural consumers of which 2,535,000 or about 67 per cent were classified as farms (i.e.) the Rural Electrification Administration borrowers were serving in 1952 about 53·5 per cent of all farms served.

The R.E.A. policy was always to establish a nation-wide programme, which eventually would stand on its own feet. The aim has been to develop independent rural electric system, each of which would take its place in the particular rural economy, in which it is located as a healthy, locally owned and managed business enterprise. Each borrower is an entirely independent co-operate body, locally owned and controlled and subject to applicable State Laws.

The average electric co-operative has become a two million Dollar local non-profit enterprise.

The R.E.A. borrowers had a total of 591,357 KW. of generating capacity in operation by 1952, and of this 300,750 KW. was steam, 254, 466 KW. was internal combustion and the balance of 36,141 KW. was hydro.

Consumption of power by farmers served by the borrower's system was 146 kwh. per month in 1950 and 165 kwh. per month in 1951.

Extract from the "Report of Sri V. P. Appadurai: Chief Engineer for Electricity, Vol. I, on Power Stations."

2. Providing Power for Irrigation.

The Bombay Government have stated that co-operative electricity production societies are proposed to be subsidised during the second Five-Year Plan in order to assist them to provide electricity for irrigation. Such assistance will be given in the part of Bombay State not served by the Electric Grid.

Already, Government have been subscribing to the share capital of such societies and advancing loans up to 1/3rd of the capital cost. But it is considered that this much assistance is not sufficient to induce them to take up supply for irrigation purposes, as income derived from the supply falls short of production costs.

In addition to the loan assistance available under the existing scheme, assistance will be given in future by way of non-recurring subsidy to-

wards capital cost to the extent of 25 per cent of the additional capital cost entailed in the supply of electricity for irrigation purposes. Twelve electricity production societies are proposed to be assisted with loans up to 1/3rd of the capital cost and eight of these, with subsidies on the scale mentioned above, for enabling them to supply electricity at economic rates for irrigation purposes; a provision of Rs. 14 lakhs as loan and Rs. 2·4 lakhs as subsidy has been proposed in the Second Five Year Plan.

During the current year, it is proposed to have three units, which will be assisted with loans, out of which, two will also be considered for subsidy for supplying power for irrigation purposes. A provision of Rs. 25 lakhs as loans and Rs. 0·73 lakh as subsidy has been made for the purpose.

The promoters desirous of forming co-operative electricity production and supply societies have to apply for and obtain licences under Section 3 of the Indian Electricity Act, 1910, and get the part of the schemes regarding the supply of power for irrigation purposes approved by the Agricultural Engineer to Government, Bombay State, Poona.

The loan will carry interest at 4½ per cent per annum, and is repayable in 15 annual instalments.

" The F. E. U. of India"
—*Sep.* 1956.

3. Fibre Glass Poles.

Reports from the United States speak of the first demonstration of the newly developed fibre glass poles.

The demonstration is said to have indicated that the new poles are lighter, easily transportable, and can be built to precise standards of strength. Their insulating value is better than wood poles, and their estimated life is longer. In addition, they are said to be impregnable to wood-peckers, termites and sign nailers.

A standard 35 ft. long pole is capable of being lifted by two men, compared with usual six for ordinary poles. The weight at that length is 150 pounds compared with 450 pounds for cedar and 750 pounds for pine poles. The pole is said to be of 11 inches in diameter and capped at each end, is a hollow cylinder of fibre glass and plastic. The tubular wall is ¼ inch thick; still the pole is said to have a strength, equal to low carbon steel.

The poles have been exposed to temperatures ranging from below zero to over 100° F. in the sun. Life expectancy of the pole is estimated over 50 years.

For climbing, detachable pole steps, are used by linemen, the metal 'steps' fitting into holes manufactured into the pole.

Cross-arms for the poles are also plastic-impregnated fibre glass. The test line made use of cross-arms that were 4 inch in diameter, 8 ft. long and clamped to the poles with metal. Another design, is a " slip through " arm, almost totally devoid of hardware, having practically the same ultimate strength of the more conventional type.

" The F. E. U. of India"
—*Sep.* 1956.

4. Underground Hydro-Electric Power Stations.

Underground power stations have been built for may years. The first is that of Snoqualmie (10,000 h.p.) in the State of Washington, U.S.A., in 1898, and shortly afterwards Brechbergmuehle in Germany (1907). Next followed Porjus in Sweden in 1914, and the power station of Brommat in the French Massif Central in 1928–31. The points in favour of an underground design are summarized below :—

(*a*) In some cases the underground solution is better suited to the contour lines or the local geologic conditions. There may be no appropriate site for the normal arrangement, with surge tank and steel penstock, or for location of the power house in a narrow valley, endangered by avalanches.

(*b*) Sometines climatic conditions are more suited to underground work. Work underground is carried out at a nearly constant temperature, regardless of outside climatic conditions ; and can proceed all the year round even when outdoor work will have to be stopped because of the cold.

(*c*) An underground power station can be built in sound rock only, but, due to the modern technique of tunnelling, may cost no more than an ordinary power-house, according to local topographical or geological conditions.

(*d*) Very high concentration of power in one installation is possible with underground power stations.

(*e*) Power Stations and penstocks being underground, there is no danger of spoiling the scenery.

"*The English Electric Journal*"
—*June* 1955.

5. Recent Developments in High Voltage Transmission.

When a power transmission system has reached a stage of development, when it has sufficient number of lines in parallel to acheive security and these lines are fully loaded it is more economical to use a higher voltage for transmitting a large increase in the power than multiply the number of lines at the existing voltage. Table below shows some of the recent extra high voltage transmission systems :—

Power Systems.	Voltage (K.V.)	Power transmitted.	Length of transmission (Miles).
(1)	(2)	(3)	(4)
Swedish System	380	300 MW.	600
British Grid System	275	360 MW.	105
	380	500 MW.	116
Bonneville Power System ..	345	..	170
	..	..	130
American Gas and Electric System,	330	300 MVA.	403

The conductors are so designed as to keep down corona loss and radio interference. The conductors used are given in the table below :—

Power System. (1)	Voltage K.V. (2)	Conductor. (3)
Swedish System ..	380	2 Conductors per phase : ACSR : each consisting of 0·11 sq.in. steel, and 0·81 sq.in. aluminium, with an outside dia. of 1·25 in., at 18 in. spacing.
British Grid System ..	275	(*a*) Twin 0·175 sq.in. (copper equivalent) ACSR at 12 in. spacing for inter-cennection. (*b*) Twin 0·4 sq. in. (copper equivalent) ACSR at 12 in. spacing for bulk transmission.
Bonneville Power System.	345	ACSR : 1·6 in. outside diameter (1·12 m. circular mills copper equivalent).
American Gas and Electric System.	330	Expanded ACSR : 1·6 in. outside diameter (802,000 circular mills copper equivalent).

Auto-transformers are preferred to two winding transformers on these E.H.V. Systems as they reduce the weight, losses, and impedance. In the case of long distance transmission systems the Chief limiting factor is transient stability. On account of the stability limitations, long lines must often be loaded far below the economical limit. Bundled conductors in spite of the mechanical problem connected with their use, have been found to increase the stability limit. It is claimed that a twin conductor line costing about 14 per cent more has increased the transmission capacity by about 30 per cent.

"*Power Engineer*"—*July* 1955.

6. World's Largest Generator.

Two of the three new turbine-generators on order for River Rouge have a capacity of 260 M.W. each. The new No. 3 turbine-generator on order for River Rouge is the World's largest with a capability of 300 M.W. According to present construction schedules, the first unit will go into service around the first part of 1956. This new 300 M.W., 400,000 h.p. now being manufactured by Allischalmers, will be serviced by November 1957. This steam turbine unit could, by itself supply electricity for a city with a population of 500,000.

"*Power Engineer*"—*July* 1955.

7. Under ground Corrosion on Rural Distribution Lines.

Studies and experience relating to underground corrosion on multi-grounded distribution lines point to the following conclusions :—

1. Excessive underground corrosion is generally a result of

galvanic action between buried copper and steel, connected to the system neutral.

2. Galvanic corrosion of anchor rods, on existing lines, can be relieved by the use of strain insulators in guys or corrosion resistant anchor rods, by substitution of galvanized steel ground rods for copper electrodes or by use of galvanic anodes. Each of these measures has advantages and limitations, that change with local conditions. Steel grounding is economical, and there is minimum danger of corrosion to other buried structures, by its use.

3. Galvanized steel ground rods should generally be used for replacement and new construction on all lines, constructed with steel anchor rods, bounded to the neutral, to minimize possibilities of excessive underground corrosion. This appears applicable to multigrounded common neutral systems generally, except where strain insulators or corrosion resistant materials are being applied for corrosion prevention.

4. Anchor-rod corrosion is the first indication of galvanic corrosion on multigrounded lines with anchor rods connected to the neutral; but, this should be recognized as a symptom, and not necessarily the entire problem. All underground structures connected to the common neutral conductor should be considered, when planning measures for improvements.

5. The attitude, that if some grounding is good, more is better, needs to be reconsidered from the standpoint of underground corrosion. Grounding in excess of the requirements for safety and lightning protection may be a major factor contributing to excessive underground corrosion.

" *Electrical Engineering* "
—*May* 1955.

8. Kansas City Service Drop System.

Aluminium conductors are used in the service drop system in Kansas City. The City Power and Light Company installs approximately 10,000 services or one million feet of cable each year using aluminium conductors. Two hard drawn insulated aluminium conductors, and a flat bare aluminium neutral, from the continuous run from pole to meter without splices or taps. The insulated conductors are covered with Neoprene, which is highly resistant to moisture penetration. When connections are made, the aluminium is cleaned and treated with a conventional inhibitor. A standard cable grip attaches the cable to the pole. Attachment to the house is made with a standard cable clamp. The cable passes through the clamp and along the house to the meter socket through a waterproof fitting. The cable is fastened along the house with straps. Maximum length of each service drop is 125 feet.

Advantages claimed for these installations are (1) elimination of power theft ; (2) elimination of contact hazard to employees and the public ; (3) more attractive appearance ; (4) convenience of installation and operation ; (5) elimination of tree trimming, abrasion of insulation power loss and interruption of service through " burn-downs ".

" *Electrical World* "—*March* 1955.

9. Electronic Combustion Control.

Commonwealth Edison's 640,000 K.W. Ridgeland Station near Chicago is the largest completely cyclone-fired power plant in the world. A total of 28 cyclone furnaces fire the plant's six boilers.

To maintain maximum firing efficiency cumbustion conditions at each cyclone are individually controlled and integrated with over-all plant operation by a Republic Electronic Control System. The system provides separate controls for primary air, secondary air, fuel feed and fuel-air ratio at each of the 28 cyclone furnaces in addition to controlling forced and induced draft fans and feed water pumps on each boiler. All told, there are more than 130 individual controls which are automatically co-ordinated for continuous proper cumbustion.

Integration of control information is greatly simplified by use of electronic circuits. Because transmission of control impulses is electrical all parts of the control system can respond simultaneously for smooth co-ordinated operation of the boilers.

"*Combustion*"—*January* 1956.

10. New devices for vibration testing.

The General Electric Company Limited has announced the availability of newly developed barium titanate transducers for use as accelerometers and strain gauges in vibration testing. These are very small in dimensions inexpensive reliable and simple to operate in conjunction with cathode ray oscilloscopes. The accelerometer is only ¾ inch long and weighs only 11 grammes unscreened; it can detect and record frequencies in the range 20 c.p.s. to 20 kc.p.s. and between 40 c.p.s. and 10 kc.p.s. is accurate within 10 per cent. The G.E.C. vibration strain guage is much more sensitive to alternating strain than typical wire-resistance gauges but does not respond to steady strain; it will operate in the frequency range 20 c.p.s. to 50 kc.p.s. and can be used not only to detect but also to excite vibration. Two standard sizes are made, measuring ¾ inch by ¼ inch by 0·35 inch., and ¾ inch by ½ inch by 0·35 inch, respectively.

"*Power and Works Engineering*" —*June* 1956.

11. On Load Washing of Economisers and Airheaters.

E. Green and Sons Limited, of Wakefield, England, have for many years specialised in the design and construction of economisers and airheaters.

The principles involved and the results being secured by on-load washing are readily appreciated. The "bad" coals of to-day are bad chiefly because of their high sulphur content. This sulphur causes corrosion in the economiser and airheater, if it is allowed to remain, in the form of sulphatic deposits, on the surfaces. It is found, that the sulphatic deposit is easily soluble in water in early stages and can be removed by washing.

Off-load washing has been successfully applied for some years. But off-load washing cannot give 100 per

cent availability with full efficiency; on-load washing, on the other hand, if properly carried out, does not allow the efficiency and the load to fall but maintains constant availability.

A technique of using raw water has now been devised on the principles stated below :—

(*a*) Copious quantities of water must be used, in a very short time; (*b*) At any one moment only a narrow section of the economiser or airheater must be in the water curtain; (*c*) The water must be applied in such a way that adjacent tubes are similarly cooled, but only for a short part of their length; (*d*) The form of the heating surface, whether economiser or airheater, must be such as to lend itself to rapid cleaning by washing. Round tubes are not so satisfactory as special sections; (*e*) Attention must be given to the material of construction. For both economisers and airheaters the best material is undoubtedly cast iron; (*f*) Attention must be given to the arrangement of the plant, so that on-load washing can be applied without detriment to other parts of the equipment.

"*Power and Works Engineering*"
—*June* 1956.

12. High temperature Solar Furnace.

A solar furnace has been completed at Fordham University, U.S.A. for fundamental research at high temperatures. A covered army search light provides the 60 inches parabolic mirror. In initial runs tempaeratures up to 2,350°C. have been recorded; with ideal atmospheric conditions a temperature as high as 4,500°C is expected to be btained.

The sample is held on the platform by an aluminum vice like arrangement. Only a small area reaches the high temperatures required to cause melting, and adjacent areas which are relatively cool serve as the container. Temperature is regulated by changing the position of a hollow aluminium cylinder suspended in the centre of the searchlight. As the cylinder is moved up, less of the radiation from periphery of the mirror reaches the sample.

Following are the advantages of a solar furnace over the more conventional gas or electric furnace; possibility of obtaining much higher temperatures; concentration of the heat in a small area; extremely rapid heating; accessibility of the sample for continuous observation during heating; and easily obtainable controlled atmospheres.

"*Chemical Engineering News*"
—1955.

13. Silicon power Rectifier.

A silicon power rectifier developed by the Bell Telephone Laboratories claimed to have an efficiency of more than 98 per cent of the theoretical limit. Two of the new rectifiers, of the size of a pea, linked together and mounted on a cooling fin, will furnish more than 20 amp. d.c. at 100 V. This amounts to 2,000 W.—with only 20 W. lost through heat. The new silicon rectifiers provide 5,000 times more current than conventional rectifiers of the same size, thus permitting miniature operating units.

"*Journal of Scientific and Industrial Research*"
—*January* 1956.

14. Tit-Bits.

Bark-burning Unit.—C-E Bark burning Unit for a paper Company in U.S.A. is a very large unit; capacity—450,000 lb. steam per hour 1,335 psi; 958°F. It is designed to burn bark, natural gas, oil or any combination thereof.

Wet Coal Flows Better over Stainless-Clad Steel.—At the R. Paul Smith Station of the Potomac Edison Company, U.S.A., Stainless-clad coal handling equipment installed to date includes three coal chutes and one 36 feet coal pipe. These four units have averaged 3 years of service with practically no stoppage of coal flow.

A layer of stainless steel is integrally bonded to strong, low-cost carbon steel backing plate. The combination provides lower initial cost than solid high-alloy plate, yet provides the same long-term, maintenance-free protection.

Cross-Compound Turbines offer greater operating economy.—The cross compound design is adopted in Unit No. 2 Will County Station. Commonwealth Edison Company, U.S.A.

Separation of high-and low-pressure sections allows greater efficiency in each. The 1,800 rpm. speed of the low-pressure section permits use of longer, last-stage buckets which provide more efficiency at low exhaust pressures.

The 3,600-rpm. high-pressure section's opposed-flow design avoids severe temperature gradients with their thermal distortion by concentrating high steam temperatures in a small area of the casing. This feature results in outstanding efficiency. Fuel savings on a typical 250 M.W. cross-compound unit can be as much as 50,000 pounds of coal per year.

Out-door Station.—Put into service early in 1953, the 81,500 K.W. Arbuckle Station of Oklahoma Gas and Electric Company at Sulphur, Oklahoma, is the first completely out-door type station—as well as the largest single generating unit—in the O.G. and E. system, U.S.A.

Dogs bribed with candy don't bite.—Dog bite is a hazard, which a meter-reader, in an Electric Supply Undertaking, may have to face in suburban areas in the course of his duties.

According to American reports it has been discovered, that one meter reader had a 15-year record of no bites or other difficulties with dogs. It has been found, that he carried a box of dog-candy or biscuits in his pocket, which he used to make friends with vicious dogs on his beat.

This has led to undertakings, making such sweets standard equipment, resulting in no dog bite cases, and also in the process, avoiding arguments, which might follow such incidents.

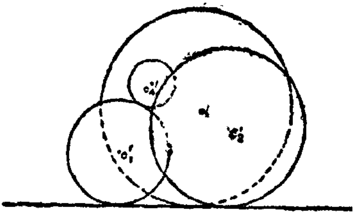
The Problem Corner

Problem No. 1.—The problem below, is offered to the members for their study and solution :—

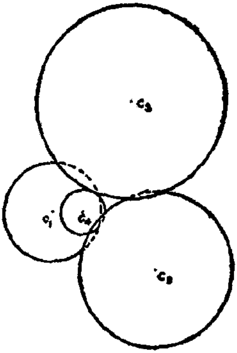
" There are 3 spheres of 5, 8, and 10 inches diameter on ground touching one another. A fourth sphere is placed over them. Its size is such that a plane surface placed over the three spheres, touches the fourth sphere also.

Determine by calculation and drawing the diameter of the 4th sphere. A plan and elevation of the arrangement are given below.

The above problem was suggested by Sri S. Raman, Assistant Engineer (Electrical). Solutions to this problem should reach the Editor on or before 15th July 1957.



ELEVATION



PLAN

Social and Personal

Chief Engineer leaves for Canada.

Sri V. P. Appadurai, Chief Engineer for Electricity left Madras, in the morning of 9th December 1956, by air, for Bombay, enroute to Canada, in connection with the purchase of equipments for the Kundah H.E. Project.

Postings and transfers.

1. Sri L. Ekambaram on return from leave joined as Superintending Engineer (Generation) Hydro Areas, Erode, on 16th June 1956, vice Sri V. K. Govinda Menon granted leave from 16th June 1956 to 30th September 1956.

2. Sri M. B. Kandaswami relinquished his office as Chief Operation Engineer (South) on 23rd August 1956 to join as Member of the Railway Service Commission.

3. Sri N. R. Narasimhamurthy was transferred as Chief Operation Engineer (South) from 23rd August 1956.

4. Sri A. R. Narayana Rao was re-appointed as Chief Operation Engineer and he joined as Chief Operation Engineer (North) on 23rd August 1956.

5. The post of Chief Construction Engineer was revived and Sri D. Rajagopalan, Superintending Engineer (Civil) was appointed as Chief Construction Engineer on 29th September 1956.

6. Sri V. K. Sethuraman, Divisional Electrical Engineer held full additional charge of the post of Superintending Engineer (Distribution), Madras Electricity System from 23rd August 1956.

7. The following Assistant Engineers (Electrical) were promoted as Divisional Electrical Engineers :—

1. Sri A. Nataraja Mudaliar.
2. ,, P. R. Narasimhan.
3. ,, P. Narayanan.
4. ,, K. Mani.

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The authors of papers and articles are requested to scrutinize carefully the typed or cyclostyled copies before forwarding them. Equations and formulæ are best inserted in hand. Two sets of drawings should accompany an article. One set should be mere line-work without any lettering and the other complete with lettering, the former preferably on tracing cloth. Colour wash or line and pencil shades cannot be reproduced in line blocks. They should be replaced by hatching, and colour lines by dashed chain or thicker black lines. The size of drawings or line blocks should generally be double the size to be reproduced in print.

It is desirable that the use of the first person should be avoided. When a specific statement is to be made, it should be written : "The author submits . . . . . ", "The author holds the opinion . . . . . . ", etc. It is desirable that articles or papers should be *sectionalized by giving* suitable 'sectional headings'. Avoid long and involved sentences ; short sentences are more effective and less likely to be misinterpreted. Do not begin a new sentence with a numeral, write the number in full as word. Place zero before the decimal point, when the figure represents something less than unity; thus : 0·75. Place a comma to mark the thousands in number of four figures and more ; thus : 2,127,356, and, in the case of Rs. thus : 27,26,127. Do not write in the text of the article 8′ 6″ by 4′ 3″ but as 8 feet 6 inches by 4 feet 3 inches or as 8·5 feet by 4·25 feet. For numbers under 10—write out in full, if not followed by an abbreviation; thus, write nine days, but 9 lb., not nine lb. For numbers over ten use numerals.

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